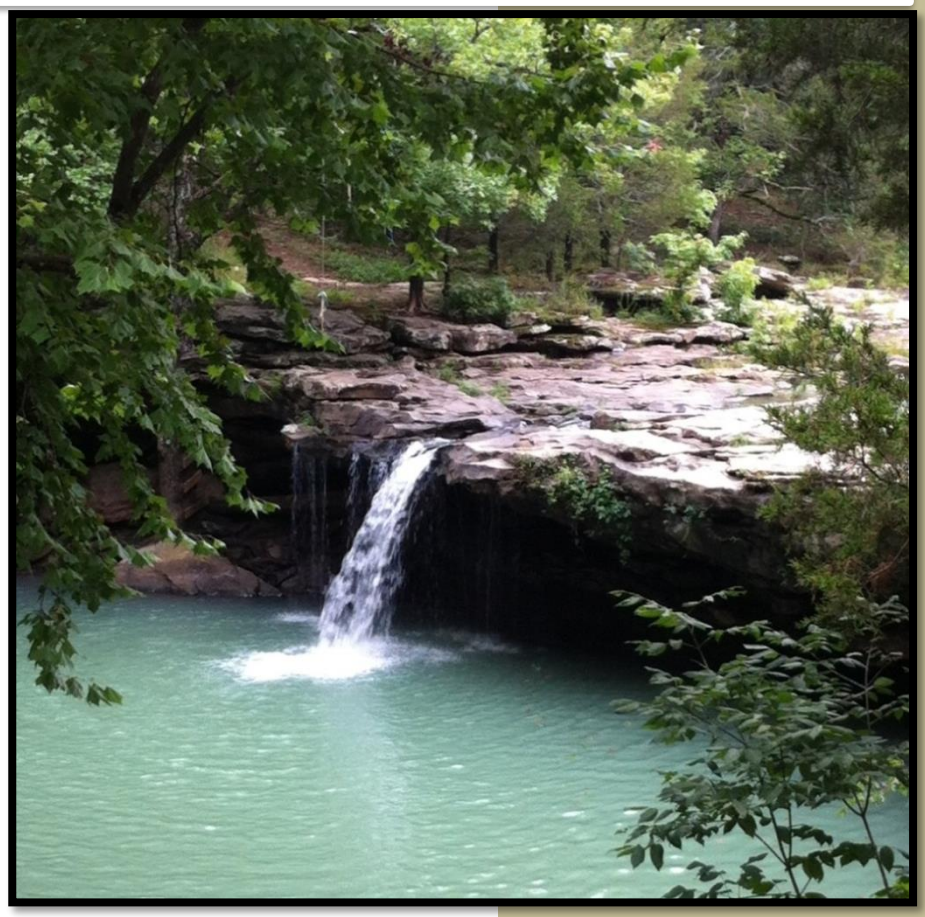
2024

ASSESSMENT METHODOLOGY



For the Preparation of:

The 2024 Integrated Water Quality Monitoring and Assessment Report

Pursuant to Clean Water Act Sections 303(d) and 305(b)

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1.0 ASSESSMENT BACKGROUND

Section 305(b) of the Federal Water Pollution Control Act (hereinafter "Clean Water Act") requires states to perform a comprehensive assessment of the State's water quality to be reported to the U.S. Environmental Protection Agency (EPA) every two years. The report provides information on the quality of the state's waters; the extent to which state waters provide for the protection and propagation of a balanced population of fish, shellfish, and wildlife, and allow recreational activities in and on the water; and how pollution control measures are leading to water quality standards attainment.

In addition, Section 303(d) of the Clean Water Act requires each state to identify waters where existing pollution controls are not stringent enough to achieve state water quality standards and establish a priority ranking of these waters. States must develop Total Maximum Daily Loads (TMDLs) or other corrective actions for the identified waters. TMDLs describe the amount of each pollutant a waterbody can receive and not violate water quality standards. States submit the list of impaired waters (303(d) list) to EPA. EPA has the option to approve, disapprove, or take no action on the list within 30 days of submission.

Arkansas Department of Energy and Environment, Division of Environmental Quality (DEQ) follows the specific requirements of 40 C.F.R. § 130.7-130.8 and EPA's most current 305(b) reporting and 303(d) listing requirements and guidance when developing this assessment methodology. Current EPA guidance recommends producing one report combining requirements of the Clean Water Act for Sections 305(b) reporting and 303(d) submissions. This is, in general, referred to as the Integrated Report (IR).

Arkansas's combined report is the *Integrated Water Quality Monitoring and Assessment Report* (305(b) Report). The 305(b) Report describes the quality of all of the surface waters of the state that were evaluated for a specified assessment period (period of record (POR)). This report is prepared using the *Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b), and 314 of the Clean Water Act* (EPA 2005) which is supplemented by memoranda regarding development of the 2008, 2010, 2012, 2014, 2016, 2018, 2022, and 2024 305(b) Reports (EPA 2006, 2009, 2011, 2013, 2015, 2017, 2021, and 2023 respectively). Arkansas's waters are evaluated in terms of whether their assigned water quality criteria and designated uses, as delineated in the Arkansas Pollution Control and Ecology Commission's (APC&EC) *Rule[1] 2 Water Quality Standards for Surface Waters of the State of Arkansas* (APC&EC 2022), herein referred to as Rule 2, are being attained.

Rule 2 provides the foundation for the 305(b) Report, establishing water quality standards for surface waters of the State of Arkansas; designated uses associated with those water quality standards; and criteria and policies established to protect, maintain, and restore designated uses. Water quality data are assessed for compliance with Rule 2 to determine impairment and designated use support, based upon the frequency, duration, and/or magnitude of water quality criteria exceedances as delineated in DEQ's assessment methodology.

[1]Act 315 of 2019 was enacted by the Arkansas General Assembly requiring revisions of the use of Rule in lieu of Regulation.

2.0 INTEGRATED REPORTING CATEGORIES

Arkansas's waters are assessed based on water quality criteria and designated use support, according to Rule 2 and this assessment methodology. Water quality standard attainment is determined based on support of designated uses and/or criteria in place to protect those designated uses. An assessment unit (AU), previously referred to as a monitoring segment, is the basic unit of record for conducting and reporting water quality assessments. AUs are individual stream reaches, lakes, lake areas, or other defined waterbodies and are grouped by planning segments and 8-digit hydrologic unit codes (HUC). AUs are delineated using GIS layers and several real world considerations such as tributaries, land use boundaries, point source dischargers, monitoring stations, physical breaks, and other factors.

Arkansas's assessments are formatted to reflect EPA's 305(b)/303(d) Integrated Report (IR) guidance (EPA 2005, 2006, 2009, 2011, 2013, 2015, 2017, 2021, and 2023) which suggests placing AUs into the following five integrated reporting categories upon assessment. AUs may be assessed as Category 1, 'support' if all water quality criteria and designated uses, for which data are available, are attained. AUs may be assessed as 'non-support' if any water quality criteria or designated use is not attained, and may be placed in Category 4 or 5, as appropriate. AUs may be placed in Category 3 if there is not enough information to make a scientifically defensible attainment decision. Historically, Category 2 is rarely used in Arkansas.

Some impaired AUs will be distinguished between pollutant causes currently without a TMDL (Category 5) and pollutant causes for which TMDLs have already been approved (Category 4a). In some instances, a regulatory response outside of a TMDL is permissible and the AU/pollutant pair is assigned to Category 4b (alternative pollution control) or Category 5r (formerly 5-alt). In instances where non-attainment is not caused by a pollutant, AUs will be placed in Category 4c. Examples of this would be naturally occurring deviations from current criteria where site specific criteria would be more appropriate but are yet to be developed. Note that Category 4 waters are not part of the 303(d) list of impaired waterbodies; however, a list of Category 4 waters are public noticed along with the 303(d) list (Category 5).

The 303(d) list of impaired waterbodies (Category 5) consists of AUs not supporting one or more designated use and/or not meeting water quality criteria. Category 5 is prioritized by DEQ for planning and management purposes in accordance with 40 § C.F.R. 130.7 (b)(4) which states: "The list required under §§ 130.7(b)(1) and 130.7(b)(2) of this section shall include a priority ranking for all listed water quality-limited segments still requiring TMDLs, taking into account the severity of the pollution and the uses to be made of such waters and shall identify the pollutants causing or expected to cause violations of the applicable water quality standards. The priority ranking shall specifically include the identification of waters targeted for TMDL development in the next two years." Therefore, any waterbody ranked as "high" within Category 5 may be targeted for TMDL development.

Category 1. Attains all water quality criteria and supports all designated uses; categorized by existence of a TMDL or not for one or more constituents.

1a. Attaining all water quality criteria and supporting all designated uses, no use is threatened. No TMDL exists for any constituents.

1b. Attaining all water quality criteria and supporting all designated uses; however, a TMDL remains in place for one or more constituents.

Category 2. Available data and/or information indicate that some, but not all of the designated uses are supported.

Category 3. Insufficient data and/or information are available to make a use support determination.

3a. No data available.

3b. Insufficient data available.

- Data do not meet all quality or quantity requirements outlined in this assessment methodology;
- Waters in which the data are questionable because of Quality Assurance and/or Quality Control (QA/QC) procedures and/or the AU requires confirmation of impairment before a TMDL is scheduled.
- Where limited available data and/or information indicate potential impacts or downward trends in water quality, the following water bodies in Category 3 may be prioritized (on a case-by-case basis) for additional investigation: waters designated as ERW, ESW, or NSW; domestic water supplies; and waters located in known karst areas.

Category 4. Water quality standards are not attained for one or more designated uses but the development of a TMDL is not required because:

4a. A TMDL has been completed for the listed parameter(s); or

4b. Other management alternatives are expected to result in the attainment of the water quality standard; or

4c. Non-support of the water quality standard is not caused by a pollutant.

Category 5. The water body is impaired, or one or more water quality standards are not attained. Water bodies in Category 5 will be prioritized as:

High

- Truly impaired; develop a TMDL or other corrective action(s) for the listed parameter(s).

Medium

- Waters currently not attaining standards, but may be de-listed with future revisions to APC&EC Rule No. 2, the state water quality standards; or

- Waters which are impaired by point source discharges and future permit restrictions are expected to correct the problem(s).

Low

- Waters currently not attaining one or more water quality criteria, but assessed designated uses are determined to be supported; or
- There is insufficient data to make a scientifically defensible decision concerning designated use attainment. Where more data and/or information are needed to verify the need for TMDL development or other corrective action(s) for the listed parameter(s), the following water bodies in Category 5 may be prioritized (on a case-by-case basis) for additional investigation: waters designated as ERW, ESW, or NSW; domestic water supplies; and waters located in known karst areas; or
- Waters DEQ assessed as unimpaired, but were assessed as impaired by EPA.

r (formerly alt.)

- Waters where alternative restoration approaches may be more immediately beneficial or practicable in achieving WQS than pursuing the TMDL approach in the near-term.

3.0 DATA MANAGEMENT

Data assessment forms the basis of water quality standard attainment decisions. In order to conduct accurate assessments, evaluated data must:

- reflect current ambient surface water quality conditions,
- adhere to robust quality and quantity considerations,
- and represent accurate temporal and spatial requirements.

Data are assessed based on the current EPA-approved water quality standards for the State of Arkansas (APC&EC, 2020) and this assessment methodology. In some cases, a weight of evidence approach may be used to supersede a preliminary assessment. When this occurs, justification will be provided within the 305(b) report as well as submitted with the 303(d) list for public notice and any supporting documentation will be provided. A more robust discussion of how final attainment decisions are determined can be found in Section 3.8 Final Attainment Determination Process.

3.1 WATER QUALITY DATA TYPES AND CONDITIONS

3.1.1 Data Types

Water quality data are collected in a variety of ways in Arkansas and are utilized differently for assessment purposes. Data sets are generally classified as discrete or continuous. Unless otherwise specified, assessment methodologies are designed for use with discrete data sets. When continuous data are used for assessment purposes, assessment methodologies will be identified as such. Different data types will not be combined for assessment purposes. If multiple data types exist for one AU, both will be assessed, and the most protective assessment will apply

3.1.1.1 Discrete Data

Discrete data are generally characterized as data generated from samples taken at the same location with a significant amount of time passing, or a significant event (such as a storm event) occurring between each sample such that potential changes in water chemistry can be noted. These samples can be *in situ* measurements (pH, temperature, etc.) or grab samples to be taken to a lab for analysis (metals, toxics, etc.). An example of a discrete data set would be DEQ's ambient monitoring network where samples are collected from the same locations on a monthly basis. Discrete sampling works well when resources are limited, allowing entities to sample a larger area over time.

3.1.1.2 Continuous Data

Continuous data are generally characterized as data generated from a series of discrete *in situ* samples taken at frequent, regular intervals at the same location over time. Typically, these data are collected using a continuous logging meter taking measurements in regular time increments such as from once a second to once an hour. Water quality parameters typical of this collection are pH, dissolved oxygen, and temperature.

For assessment purposes, DEQ considers two types of continuous data: long-term and short-term.

- Long-term continuous data spans long time periods, from weeks to years. Long-term continuous data are typically collected at minute to hourly intervals.
- Short-term continuous data spans a shorter time frame, typically a 48 – 96-hour period. These time periods target diurnal shifts in certain water quality parameters and readings are typically collected every few seconds or minutes.

When managing data for assessment purposes, both long-term and short-term continuous data taken in less than hourly readings (example.: data recorded every fifteen minutes) will be calculated into hourly averages. All long-term and short-term assessments require at least hourly readings. Short-term continuous data must span 90% of the 24-hour period to be used for that day. Long-term continuous data must span ~90% of the applicable seasonal requirement dependent on the parameter being assessed.

3.1.2 Data Conditions

At times, data results are "censored," meaning they are reported as less than some value, greater than some value, or as an interval or range of numbers. For data processing and management, DEQ will handle these data in the following ways.

3.1.2.1 Data below detection limits

Data that are lower than detection limits of laboratory methods or equipment are typically represented as less than the numerical detection limit. In these cases, DEQ will use one-half the detection limit and assign that value as the numeric result for that data point (e.g. <0.05mg/L = 0.25mg/L). (Clarke 1998, Scott et al. 2016, Croghan and Egeghy 2003, and Dixon 2005)

3.1.2.2 Data above detection limits

Data that are greater than detection limits of laboratory methods will be represented as the numerical detection limit (e.g.: >1500cfu/100 mL= 1500cfu/100mL) as long as the detection limit is greater than applicable criteria. Maximum detection limits that are below applicable criteria will not be used for assessment purposes.

3.1.2.2 Other data conditions

Some data are represented as approximate. Approximate data will be used in assessments by dropping the approximate sign and using the whole number value (e.g. ~125cfu = 125cfu).

3.2 DATA ASSEMBLY

Pursuant to 40 C.F.R. § 130.7(b)(5), DEQ assembles and considers all existing and readily available water quality data and information, from DEQ and outside entities, to make water quality standard attainment decisions. Data are quality assured for use by determining adherence (or not) to data quality considerations outlined in this document (Sections 3.3 and 6.0 and subsections thereof).

The largest percentage of data used in the assessment of Arkansas's water quality are generated as part of DEQ's water quality monitoring activities, described in the *State of Arkansas's Water Quality Monitoring and Assessment Program, Revision 6* (DEQ 2020). Additionally, local, state,

and federal agencies, and other entities are solicited by DEQ to provide water quality data that meets or exceeds DEQ's QA/QC protocols.

Any entity may submit water quality data to DEQ without solicitation. All data received will undergo a quality assurance process to determine if it can be used. The 305(b) report will include a list of all outside entities who provided data as well as a map of where data were collected that were used in assessments.

PERIOD OF RECORD FOR THE 2024 305(b) REPORT:

Metals and ammonia toxicity analysis: *April 1, 2020 through March 31, 2023*

*Beaver Lake site specific nutrient criteria: *January 1, 2018 through December 31, 2022*

All other analyses: *April 1, 2018 through March 31, 2023*

*Beaver Lake period of record is for data collected for analysis of the site-specific water quality criteria that apply to the old thalweg near Hickory Creek (Rule 2.509).

3.2.1 No New Data

If no new qualifying water quality data have been generated for an AU during the current period of record, water quality standard and designated use attainment decisions from the preceding assessment period will be carried forward unless a substantial change in water quality standards or assessment methodology has occurred. If substantial changes in water quality standards or assessment methodology has occurred since the preceding assessment period, and those changes would affect previous assessment decisions, the data from the preceding period of record may be re-assessed using newly-adopted water quality standards and newly defined methodology to determine current water quality standard attainment.

3.3 DATA QUALITY CONSIDERATIONS

DEQ maintains a strong commitment to the collection and use of high quality data to support environmental decisions and regulatory programs. DEQ uses data submitted by various entities in different ways, depending on the quality and quantity of the data; however, all data submitted to DEQ will undergo a quality assurance process to determine if it can be used. Although all existing and readily available water quality data are considered, not all data can be used to make assessments or attainment decisions.

Data must adhere to data quality requirements as defined below.

- Phase I requirements are general to all parameters.
- Phase II requirements are specific to the parameter being assessed. Phase II requirements are explained in more detail in Section 6.0 and subsections thereof.

Data sets that meet all Phase I and Phase II data quality requirements can be used for attainment decisions. In some cases, a weight of evidence approach may be used to supersede Phase II requirements. When this occurs, justification will be provided within the 305(b) report. A more

robust discussion of how final attainment decisions are determined can be found in Section 3.8 Final Attainment Determination Process.

Phase I Data Quality Requirements

Essential data requirements:

- Be characteristic of the main water mass or distinct hydrologic areas. E.g., not taken within a mixing zone, side channel, tributary, or stagnant back water, etc.
- Be reported in standard units recommended in the relevant approved method and that conform to Rule 2 or can be directly compared or converted to units within Rule 2.
- Have been collected and analyzed under a QA/QC protocol equivalent to or more stringent than that of DEQ. Data collection protocols (Quality Assurance Project Plans (QAPPs) and Standard Operating Procedures (SOPs), as apply) must accompany the data.
- All laboratory analyzed parameters (not *in situ*) must be analyzed pursuant to the rules outlined in the Environmental Laboratory Accreditation Program Act, Ark. Code Ann. § 8-2-201 *et seq.* The name and location of the laboratory should accompany the data.
- Be accompanied by precise collection metadata such as time, date, stream name, parameters sampled, and sample site location(s), preferably latitude and longitude in either decimal degrees or degrees, minutes, seconds.
- Be received in the template provided in the ePortal data submission platform or compatible format not requiring excessive formatting by DEQ.
- Have been collected within the POR for the current assessment cycle.

Phase II Data Quality Requirements

Phase II data quality requirements will be specific for each parameter and will be detailed in the appropriate subsection of section 6.0 Specific Standards.

These requirements apply to the entire data set for a given AU, whether individual or aggregate, that will be considered for assessment.

- Meet sampling temporal conditions described for each parameter or designated use being assessed. These conditions include season (time of year) such as “critical season,” “secondary contact season,” or “primary season,” each defined within the applicable parameter.
- Meet data quantity requirements for each parameter or designated use being assessed.
- Meet data distribution throughout the appropriate season(s) or overall time frame appropriate for each parameter or designated use being assessed. Samples should always be “evenly distributed” for the temporal conditions outlined for each parameter. “Evenly distributed” is defined in Section 6.0.
- Meet sample spatial requirements described for each parameter or designated use being assessed. These can include lake sampling depth, specific sampling locations, or other spatial requirements.

3.3.1 Aggregating Data Sets

Data sets are defined as those collected by a single entity, at a single site, under a single QAPP. If multiple data sets pass Phase I data quality requirements for the same AU, they may be combined and considered as an aggregate data set for Phase II data quality requirements. If only one data set for a given AU passes Phase I data quality requirements it will be the only data set considered for Phase II data quality requirements.

AUs are delineated to represent homogenous waters with regard to water quality. Therefore, it follows that any independent sample taken from an AU is representative of conditions within that AU. Occasionally more than one monitoring station with available data exists within an AU or

several entities may provide data for the same monitoring location. Since each independent sample is considered to be representative of the AU at the time of collection, aggregation of independent samples into one data set within an AU is appropriate. Aggregation can occur for data from the same entity or from different entities.

If two entities sample the same parameter on the same AU on the same day, those data will be considered duplicates. Duplicate data points per day will be omitted, regardless of sampling entity, and only the most protective data point per day per AU will be retained. Data sets of different types (e.g. discrete vs. continuous) will not be combined into an aggregate data set.

3.4 DATA QUANTITY CONSIDERATIONS

DEQ strives to follow EPA guidance, which encourages collection of adequate data to make well-grounded attainment determinations (EPA 2005). Use of limited data is acceptable to EPA as limited financial, field, and laboratory resources often dictate the number of samples that can be collected and analyzed (EPA 2002). EPA has not established, required, nor encouraged the establishment of rigid minimum sample set size requirements in the water quality standards attainment status determination process (EPA 2005). As such, EPA discourages the use of target sample sizes applied in an assessment methodology as absolute exclusionary rules (EPA 2005).

However, EPA recognizes that assessments based on larger sample sets are more likely to yield accurate conclusions than assessments based on smaller sample sets, and that it may be appropriate to identify an initial sample size screen, but also provide for a further assessment of sample sets that do not meet the target sample size (EPA 2005).

DEQ requires a minimum of 10 water quality samples to make water quality criteria and designated use attainment decisions. Exceptions to the 10 sample minimum include bacteria, radioactivity, toxics, and ammonia. The primary goal of obtaining 10 data points is to protect against the occurrence of Type I and Type II errors. A Type I error would result in assessing an AU as non-support when it is actually fully supporting its criteria and uses. A Type II error occurs when an assessment unit is assessed as support despite it actually not meeting its criteria or uses.

3.5 DATA REPRESENTATIVENESS CONSIDERATIONS

Spatial and temporal representativeness of data and information must be considered when characterizing annual ambient conditions for a given AU. Specifics of spatial and temporal distribution will be outlined within each parameter in Section 6.0 and subsections thereof

Spatial and temporal representativeness of a grab sample is a qualitative assessment addressed primarily in sample design, through selection of sampling sites, and use of procedures that reflect project goals and environment being sampled (i.e., monitoring the presence and magnitude of toxicity at specific sites for potential impacts on aquatic life may require specialized parameter sampling).

For assessment purposes, grab samples from a given monitoring site are considered representative of the water body for that distance upstream and downstream in which there are no significant influences to the waterbody that might cause a change in water quality (e.g., point source discharges, confluence with another stream, etc.) or when there is an absence of contextual information indicating unstable hydrologic conditions, such as: 1) precipitation, 2) stream flow, 3) differing land use patterns, or 4) historic patterns of pollutant concentrations in the AU. The QAPP or work plan under which the data were collected should provide context for data representativeness and is required during data submission.

Continuous data are considered representative when the data set accurately represents seasonality in the waterbody. Data sets with significant blocks of missing time that do not reflect ambient conditions will not be used for assessment purposes. Generally, continuous data sets are used that contain 90% of the temporal requirements.

3.6 STATISTICAL CONFIDENCE

Past EPA guidelines (EPA 1996 and 2002) have recommended listing water body segments as impaired (for conventional pollutants) when "10% of measurements exceed the water quality criterion." Making attainment decisions by simply applying a literal percent exceedance rate (10 exceedances out of 100 equals 10%) is referred to as a "raw score" assessment method. While this "raw score" assessment method can be applied, it errs significantly toward making false positive listings (Washington State Department of Ecology 2002).

In an effort to limit or reduce false positive (Type 1 error) listings, DEQ utilizes binomial distribution methodology for certain parameters, as appropriate. It will not be used on parameters where only one or two excursions of the criteria will result in an assessment of non-attainment such as toxics, radioactivity, and ammonia. Additionally, binomial distribution method will not be applied to bacteria data due to assessment language established in Rule 2.507. The binomial distribution method will be applied to the following parameters: temperature, turbidity, pH, dissolved oxygen, and minerals.

When the binomial distribution method is not applied, the specific method used for each parameter is described within applicable Sections 6.1- 6.12.

The binomial distribution method is a non-parametric, robust, and well known method for characterizing the probability of proportions; in this case, the percent a data set exceeds a predetermined constant. Statistical analysis methods, such as the binomial distribution method,

are used to increase the confidence level of the final decision of attainment of water quality criteria.

Use of the binomial distribution method also allows DEQ to statistically consider the water body as a whole rather than just the available sample set. The “raw score” method only determines exceedances in the available sample set, which are only a representation of the whole water body. The binomial distribution method allows for a margin of safety to statistically declare, with a set degree of confidence, that the sample set accurately represent the water body as a whole. This is more effective, from an environmental standpoint, than simply determining whether or not the sample set exceed standards.

The EPA suggests that states determine the level of error they are willing to accept during the decision making process. Statistical methods should be employed to help achieve the state’s acceptable level of error. DEQ strives to attain a greater than ninety percent (>90%) confidence level when determining the water quality attainment status of an AU. Table 1 specifies the minimum number of exceedances required per sample size to list an AU on the 303(d) list of impaired water bodies. Conversely, Table 2 specifies the maximum number of exceedances allowed per sample size to de-list a listed AU. Each table assumes >90% confidence level for a decision with exceedance rates of 10, 20, and 25 percent using the binomial distribution method.

Utilizing the mathematical functions in Microsoft Excel, the exceedance rates were calculated using the following formula:

BINOM.INV(X,Y,Z)

Where:

X = number of samples in the data set (Trials)

Y = percent exceedance rate expressed as a decimal, (Probability_s); 10%=0.10, 20%=0.20, 25%=0.25

Z = confidence level to be attained, expressed as a decimal, (Alpha) 90%=0.9

Text above in parentheses is language input for Microsoft Excel arguments.

Thus, for a data set that contains 10 samples, to be assessed on a 10% exceedance rate and attain a 90% confidence level in the final decision, the formula would be:

BINOM.INV(10,0.1,0.9)

Table 1: Minimum number of sample exceedances required to assess as non-attaining **(list)** water quality standards, using binomial distribution, with 90% confidence that the true exceedance percentage in the water body is greater than or equal to 10%, 20%, or 25%.

10% Exceedance Rate	
Sample Size	Minimum Number of Exceedances Needed to Assess as Non-Attains
10-11	2
12-18	3
19-25	4
26-32	5
33-40	6
41-47	7
48-55	8
56-63	9
64-71	10
72-79	11
80-88	12
89-96	13
97-100	14

20% Exceedance Rate	
Sample Size	Minimum Number of Exceedances Needed to Assess as Non-Attains
10-13	4
14-16	5
17-20	6
21-24	7
25-28	8
29-32	9
33-36	10
37-40	11
41-45	12
46-49	13
50-53	14
54-57	15
58-62	16
63-66	17
67-70	18
71-75	19
76-79	20
80-83	21
84-88	22
89-92	23
93-96	24
97-100	25

25% Exceedance Rate	
Sample Size	Minimum Number of Exceedances Needed to Assess as Non-Attains
10	4
11-13	5
14-16	6
17-19	7
20-23	8
24-26	9
27-29	10
30-33	11
34-36	12
37-39	13
40-43	14
44-46	15
47-50	16
51-53	17
54-57	18
58-60	19
61-64	20
65-67	21
68-71	22
72-74	23
75-78	24
79-81	25
82-85	26
86-88	27
89-92	28
93-96	29
97-99	30
100	31

Table 2: Maximum number of sample exceedances allowed in order to assess as attaining (**de-list**) water quality standards, using binomial distribution, with 90% confidence that the true exceedance percentage in the water body is greater than or equal to 10%, 20%, 25%.

10% Exceedance Rate	
Sample Size	Maximum Number of Exceedances Needed to Assess as Attains
10-11	1
12-18	2
19-25	3
26-32	4
33-40	5
41-47	6
48-55	7
56-63	8
64-71	9
72-79	10
80-88	11
89-96	12
97-100	13

20% Exceedance Rate	
Sample Size	Maximum Number of Exceedances Needed to Assess as Attains
10-13	3
14-16	4
17-20	5
21-24	6
25-28	7
29-32	8
33-36	9
37-40	10
41-45	11
46-49	12
50-53	13
54-57	14
58-62	15
63-66	16
67-70	17
71-75	18
76-79	19
80-83	20
84-88	21
89-92	22
93-96	23
97-100	24

25% Exceedance Rate	
Sample Size	Maximum Number of Exceedances Needed to Assess as Attains
10	3
11-13	4
14-16	5
17-19	6
20-23	7
24-26	8
27-29	9
30-33	10
34-36	11
37-39	12
40-43	13
44-46	14
47-50	15
51-53	16
54-57	17
58-60	18
61-64	19
65-67	20
68-71	21
72-74	22
75-78	23
79-81	24
82-85	25
86-88	26
89-92	27
93-96	28
97-99	29
100	30

3.7 IMPAIRMENT SOURCE DETERMINATION

For any monitored AU where a water quality standard has been evaluated as non-support, the source(s) of impairment will be identified using available information (field observation, land use maps, point source location, nonpoint source assessment reports, special studies, and knowledge of field personnel familiar with the water body). However, DEQ acknowledges that tracking sources of impairment can be difficult when doing so on a state-wide level.

3.8 FINAL ATTAINMENT DECISION PROCESS

For parameters that allow for both discrete and continuous data (pH, temperature, and dissolved oxygen), data types will not be combined. Discrete data and continuous data will be assessed separately. Attainment decisions will include all necessary information for future determination of attainment (i.e. season, duration of exposure, designated use). Attainment decisions will be based on the most appropriate and protective decision for the AU. Factors that could determine which data set will be used for attainment decisions could include quantity of data, quality of data sets, and time of year data were collected. A weight of evidence approach can be used to make the final attainment decision, which may differ from the initial attainment result, but an explanation will be added to the 305(b) Report.

4.0 WATER QUALITY STANDARDS

Water quality standards are comprised of:

1) an antidegradation policy,

2) designated uses, and

3) narrative and numeric criteria.

4.1 ANTIDEGRADATION

An antidegradation policy is a requirement of the federal Clean Water Act, which is designed to prevent or limit future degradation of the nation's waters. Rule 2 contains an antidegradation policy that applies to all surface waters of the state. Per Rule 2.201 existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected. Arkansas's High Quality Waters as described in Rule 2.202 and Outstanding Resource Waters, as described in Rule 2.203 are to be protected and maintained for those beneficial uses and water quality for which the outstanding resource designation was granted. These water bodies may be listed as non-support if the chemical, physical, and/or biological characteristics for which the water body was designated have been determined to be impaired or absent, as defined by the following assessment criteria. Per Rule 2.204, in those cases where potential water quality impairment associated with a thermal discharge is involved, the antidegradation policy and implementing method shall be consistent with Section 316 of the Clean Water Act, 33 U.S.C. § 1326.

4.2 DESIGNATED USES

The primary purpose of the 303(d) list of impaired water bodies is to identify those waters that are not currently supporting one or more designated uses or not attaining one or more water quality criteria. The support/non-support status of designated uses is most often determined utilizing water quality criteria or other water quality indicators. EPA guidance (2005) makes suggestions as to which water quality constituents are protective of which designated uses to determine the support status of those designated uses.

Table 3 illustrates which water quality criteria may be used either independently or together to assist in determining the support status of each designated use. Fish Consumption is not a designated use in Rule 2; however, it can be used to list a water body on the 303(d) list. Fish advisories are issued by the Epidemiology Branch of the Arkansas Department of Health (ADH). Parameters for which no assessment methodology exists in this document were not included within this table.

Table 3: Designated Uses for Arkansas's surface waters and rules used for assessment.

	Extraordinary Resource Waters, Ecologically Sensitive Water body, and Natural and Scenic Waterways Rule 2.302 (A), (B), and (C)	Primary and Secondary Contact Rule 2.302 (D) & (E)	Aquatic Life Rule 2.302 (F)	Domestic Water Supply Rule 2.302 (G)	Industrial & Agriculture Water Supply Rule 2.302 (H) & (I)	Other Uses Rule 2.302(J)
Biological Integrity Rule 2.405	•		•			
Temperature Rule 2.502	•		•			
Turbidity Rule 2.503	•					•
pH Rule 2.504	•					•
Dissolved Oxygen Rule 2.505	•		•			
Radioactivity Rule 2.506	•	•	•	•	•	
Bacteria Rule 2.507	•	•				
Toxic Substances Rule 2.508	•		•	•		
Nutrients Rule 2.509	•		•			
Site Specific Minerals Rule 2.511(A)	•		•			
Minerals Rule 2.511(C)	•			•	•	
Ammonia Rule 2.512	•		•			

4.3 WATER QUALITY CRITERIA

4.3.1 Narrative Criteria

Rule 2 contains narrative criteria (written descriptions) that apply to all waters of the state and are used to evaluate support of applicable designated uses. Narrative criteria include general descriptions, such as the existence of nuisance species, biological integrity, taste and odor producing substances, visible globules on surface waters, nutrients, and toxins.

When listing and delisting methodologies are not specified for a particular narrative criterion within the assessment methodology, the following general methods may be used. Narrative criteria are evaluated by using screening levels established by EPA or other scientific literature, if they are available, as well as other information, including water quality studies, documentation of fish kills or contaminant spills, and photographic evidence. A weight of evidence approach may be used and final attainment decisions will be justified within the 305(b) report as well as submitted with the 303(d) list for public notice and any supporting documentation will be provided.

4.3.2 Numeric Criteria

Numeric criteria are values established in Rule 2 that provide a quantitative basis for assessing designated use support, developing permit limitations, and for managing point and nonpoint loadings in Arkansas's surface waters. Listing and delisting methodologies for instream water quality against numerical criteria are outlined in Section 6.0 and subsections thereof.

5.0 BIOLOGICAL INTEGRITY

This section establishes the protocol for assessment of biological integrity for Arkansas's surface waters, per APC&EC Rule 2.405:

> *For all waters with specific aquatic life use designated in Appendix A, aquatic biota should not be impacted. Aquatic biota should be representative of streams that have the ability to support the designated fishery, taking into consideration the seasonal and natural variability of the aquatic biota community under naturally varying habitat and hydrological conditions; the technical and economic feasibility of the options available to address the relevant conditions; and other factors.*
>
> *An aquatic biota assessment should compare biota communities that are similar in habitat and hydrologic condition, based upon either an in-stream study including an upstream and downstream comparison, a comparison to a reference water body within the same ecoregion, or a comparison to community characteristics from a composite of reference waters. Such a comparison should consider the seasonal and natural variability of the aquatic biota community. It is the responsibility of the Department to evaluate the data for an aquatic biota assessment to protect aquatic life uses designated in Appendix A. Such data may be used to develop permit effluent limitations or conditions.*

ASSESSMENT METHODOLOGY FOR BIOLOGICAL INTEGRITY

Biological integrity is evaluated using macroinvertebrate and/or fish communities collected within the water body. At a minimum, paired biological and physical data must be collected using methods outlined in a QAPP with requirements equal to or more stringent than that of DEQ. Results from acute and chronic toxicity tests of vertebrates and invertebrates in ambient water can also be evaluated, when available, but are not required to make a use determination.

To assess an AU for biological integrity, determine the support status of either macroinvertebrates and/or fish using the methods outlined in Sections 5.1 and/or 5.2. Results from fish and/or macroinvertebrate community analysis, and ambient toxicity test data if available, will be used to determine support or non-support of the aquatic life designated use.

5.1 MACROINVERTEBRATE COMMUNITY ANALYSIS

Six modified metrics set forth in *Rapid Bioassessment Protocols for Use in Stream and Rivers* (Plafkin et al. 1989) are used in analysis of macroinvertebrate community samples. Each site will have a Rapid Bioassessment score derived from a multi-metric analysis, which includes:

- taxa richness,
- Ephemeroptera-Plecoptera-Trichoptera Index (EPT Index),
- Hilsenhoff Biotic Index (HBI),
- percent contribution of dominant taxa
- ratio of EPT to Chironomid taxa,
- ratio of scrapers to filter-collectors.

See *Arkansas's Water Quality and Compliance Monitoring Quality Assurance Project Plan* (DEQ 2021) at the DEQ website: https://www.adeq.state.ar.us/water/planning/surface/pdfs/2021-deq-qapp-signed-qtrak.pdf for more information. DEQ's metric modification or deviation from Plafkin et al. (1989) includes removal of the ratio of shedders to total taxa metrics and community loss index. DEQ field sampling methodologies do not always include the collection of coarse particulate organic matter (CPOM) (i.e. leaf packs) to evaluate macroinvertebrate communities. Collection of CPOM is required to calculate the ratio of shredders to total taxa. Community loss index assumes more taxa always indicates a healthier waterbody, which has not always been the case when there is a high diversity of resilient species in impaired streams. Additionally, community loss index was removed from the updated rapid bioassessment (Barbour, 1999).

The general steps for macroinvertebrate assessment are as follows:

1. Determine representativeness of data (i.e. not collected in the summer, not collected during a scouring event, collected in the richest targeted habitat)
2. Compile all sites sampled in a given ecoregion.
3. Select a subset of sites to act as references of high quality using the "Top 15% Method" as detailed below.
4. Using Plafkin *et al.* (1989), calculate 6 metrics for each reference site
5. Take the average of each metric to get the reference condition.
6. Calculate the metrics for each individual site.
7. Compare each site's metrics to the reference condition as **Percent Comparisons**.
8. Score the **Percent Comparisons** for each metric with either a 0, 2, 4, or 6 based on Table 4.
9. Sum the scores for each site and divide by 36 to create a **Scored Percentage**.
10. Determine if the **Scored Percentage** indicates support or non-support using Table 5 (< 50% is *Non-Support* and ≥54% is *Support*. This range is reserved for staff to use a weigh-of-evidence approach to make a final decision).

Reference Condition Data Requirements:

- A minimum of 17 sites are required to calculate the reference condition
- Sampling methods must be consistent across sites
- Samples taken during the summer months or immediately following a scouring event will not be considered.
- Sites must all collected in the same ecoregion

- Sites must be selected across a disturbance gradient

Reference Condition Calculation:

1. Determine the number of sites that make up 15% of the total dataset. Use conventional rounding. The minimum statistically significant number of sites for establishing reference condition is 3, hence the minimum amount of sites in the total dataset as 17 (i.e. 17*0.15 = 2.55, which rounds to 3).
2. Calculate the HBI and EPT to Chironomid Ratio (EPT:C) for each site and rank them in order of best ecological condition, (HBI = lowest score, EPT:C = highest score).
3. Using the value derived from 15% of the dataset, select the top amount of sites for each metric (i.e. 15% of 17 sites ≈3, so select the best 3 HBI scores and best 3 EPT:C scores. This may result in anywhere from 3 – 6 sites depending on the amount of overlap between the metrics).
4. Average the values for each of the 6 Plafkin *et al*. (1989) metrics to determine reference condition.

If macroinvertebrate data are submitted for the assessment cycle that do not meet the requirements needed to calculate a reference condition, DEQ may use reference conditions that were calculated previously for the applicable ecoregion if they exist. This will be notated and reflected in the 305(b) Integrated Report.

Table 4: Macroinvertebrate bioassessment metrics and scoring criteria[1].

Metric	Biological Condition Scoring Criteria			
	6	4	2	0
Taxa Richness[2]	≥80%	<80-60%	<60-40%	<40%
Hilsenhoff Biotic Index[3]	≥85%	<85-70%	<70-50%	<50%
Ratio of EPT to Chironomid Abundances[2]	≥75%	<75-50%	<50-25%	<25%
% Contribution of Dominant Taxa[4]	<20%	20-<30%	30-<40%	≥40%
EPT Index[2]	≥90%	<90-80%	<80-70%	<70%
Ratio of Scrapers to Filter-Collectors[2]	≥50%	<50-35%	<35-20%	<20%

[1] Modified from Plafkin, J.L. M.T. Barbour, K.D. Porter, S.K. Gross, and R.M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers: Benthic macroinvertebrates and fish. U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Washington D.C. EPA 440-4-89-001.

[2] Score is a ratio of study site to reference site X 100.

[3] Score is a ratio of reference site to study site X 100.

[4] Scoring criteria evaluate actual percent contribution, not percent comparability to reference site.

Table 5: Scoring criteria for macroinvertebrate community attainment decisions (modified from Plafkin et al. 1989).

	Biological Condition Category	% Comparable Estimate	Attribute
Support	Comparable to reference	≥83%	Comparable to the best situation in an ecoregion.
	Supporting	54-79%	Community structure less than reference site. Taxa richness lower and tolerant forms are more prevalent.
Non-Support	Partially Supporting	21-50%	Obvious decline in community structure with loss of intolerant forms. EPT index reduced.
	Non-supporting	<20%	Community dominated by 1 or 2 taxa, few taxa present.

If the percent comparable estimates fall between the 50-54% cutoff for support vs non-support, a weight of evidence approach may be utilized to make a final support or non-support decision using available physical, chemical, and biological data and information.

FISH COMMUNTIY ANALYSIS

DEQ's Community Similarity Index (CSI) (Table 6) will be used in the analysis of fish communities. The CSI was established utilizing information from the 1987 ecoregion survey (APC&EC 1987) and supplemented with data from additional least-disturbed streams identified by DEQ personnel. The current metric scores and similarity ranking categories were established utilizing the prevailing deviations in the ecoregion survey data set and employed best professional judgment. Ecoregion specific metric scores for watersheds (>10mi^2) outlined in Appendix I, are calculated for each site and total scores are assessed as follows:

Table 6: Fish Community Similarity Index (CSI) ecoregion values.

Ecoregion	Total Score	Category	Attribute
Ozark Highlands	**37-45**	Mostly Similar	Comparable to the best situation to be expected. Balanced trophic structure and optimum community structure present.
	25-36	Generally Similar	Community structure less than expected. Taxa richness lower than expected. Some intolerant taxa loss. Percent contribution of tolerant forms may increase.
	13-24	Somewhat Similar	Obvious decline in taxa richness due to the loss of tolerant forms. Loss of Key and Indicator taxa.
	0-12	Not Similar	Few taxa present and normally dominated by one or two taxa.
Boston Mountains **Ouachita Mountains** **AR River Valley** **Typical Gulf Coastal** **Spring-Influenced Gulf Coastal**	**25-32**	Mostly Similar	Comparable to the best situation to be expected. Balanced trophic structure and optimum community structure present.
	24-17	Generally Similar	Community structure less than expected. Taxa richness lower than expected. Some intolerant taxa loss. Percent contribution of tolerant forms may increase.
	16-9	Somewhat Similar	Obvious decline in taxa richness due to the loss of tolerant forms Loss of Key and Indicator taxa.
	0-8	Not Similar	Few taxa present and normally dominated by one or two taxa.
Channel Altered Delta **Least-Disturbed Delta**	**22-28**	Mostly Similar	Comparable to the best situation to be expected. Balanced trophic structure and optimum community structure present.
	21-15	Generally Similar	Community structure less than expected. Taxa richness lower than expected. Some intolerant taxa loss. Percent contribution of tolerant forms may increase.
	14-8	Somewhat Similar	Obvious decline in taxa richness due to the loss of tolerant forms. Loss of Key and Indicator taxa.
	0-8	Not Similar	Few taxa present and normally dominated by one or two taxa.

AQUATIC LIFE USE ATTAINMENT DETERMINATION

LISTING METHODOLOGY:

AUs may be listed as non-support when one or both of the evaluated biological communities (macroinvertebrates and/or fish) indicate perturbation/degradation (Table 7), or when one or both of the toxicity test organisms (vertebrate and/or invertebrate) fail greater than one acute or chronic ambient toxicity test in a three-year period.

Aquatic life designated use support can be assessed using both biological integrity data and water chemistry data. When only water chemistry data are available for an AU and assessment results indicate water quality impairment for temperature, dissolved oxygen, ammonia, radioactivity, site specific minerals, or toxic substances it will be assumed that the aquatic life designated use is not supported. However, if physical and biological data are collected post-assessment which indicate the aquatic life designated use is supported, the water quality impairment will remain, but it will be noted that the aquatic life designated use is being supported in the subsequent assessment cycle.

DELISTING METHODOLOGY:

AUs may be listed as support when evaluated biological communities (macroinvertebrates and/or fish, which ever community led to the impaired attainment decision) do not indicate perturbation/degradation (Table 7) or when there have been no ambient toxicity test failures, acute or chronic, in a three-year period.

Table 7: Biological community assessment determination.

Data Type	Support	Non-Support
Macroinvertebrate Community Data Available	Macroinvertebrate community structure analysis (Table 5) indicates comparable to reference or supporting	Macroinvertebrate community structure analysis (Table 5) indicates partially supporting or non-supporting*
Fish Community Data Available	CSI score (Table 6) is either mostly or generally similar; general presence of sensitive and indicator species	CSI score (Table 6) is either somewhat or not similar; absence of sensitive and indicator species*

* The aquatic life designated use may be assessed as support or insufficient data available, despite an initial evaluation of non-support, if it is demonstrated that the non-support assessment is due to unrepresentative biological community data and not toxicity; based on acceptable variances in ecoregion community structures. Under certain conditions, biological community data can be skewed due to an unrepresentative sample, which includes but is not limited to:

- Collection of irruptive species (e.g., large percentage of young-of-year in an isolated area that is not representative of the entire reach), which could trigger an inaccurate ‘non-support’ determination.
- Transitional areas between ecoregions.

A weight of evidence approach is used in these circumstances to prevent the inappropriate listing of waters. If a support or insufficient data determination is made due to an unrepresentative sample, it will be explained in detail in the 305(b) Report and supporting documentation will be provided.

6.0 SPECIFIC STANDARDS

Per Rule 2.501 (Applicability), unless otherwise indicated, the following specific standards shall apply to all surface waters of the state at all times except during periods when flows are less than the applicable critical flow. Streams with regulated flow will be addressed on a case-by-case basis to maintain designated instream uses. These standards apply outside the applicable mixing zone.

6.0.1 General Description of Phase II Data Quality Requirements

In general, Phase II requirements are categorized by

- temporal,
- distribution and quantity,
- and spatial qualities.

Phase II data quality requirements are discussed in detail for each parameter within their respective section (6.1 - 6.12). Each general category is described below.

Temporal requirements

Temporal requirements relate to time of year, season, or other time dependent sample collection considerations. If a parameter does not have a particular season, such as pH, temporal requirements many not be listed for this parameter; or the temporal requirement may read "year round." These parameters should be collected throughout the year without preference to any particular season or time of year. Conversely, a parameter with specific seasonal considerations, such as bacteria, will have temporal requirements listed for the particular sampling season(s).

Distribution and quantity requirements

Distribution requirements are intended to be a guideline unless otherwise explicitly stated. In general, the term "month" refers to a 30-day period rather than a calendar month. If more samples are taken over a longer time period, then DEQ would assess the data set for appropriate distribution. "Evenly distributed" is meant to be a general guideline for sample distribution. It does not mean that monthly samples must be taken exactly 30 days apart without exception or that an exact number of days must exist between each sample in a data set. "Evenly distributed" is also intended to guard against samples being clumped or concentrated toward one time of the year when the parameter should be collected year round. DEQ welcomes entities to ask about sample distribution prior to finalizing sampling plans for data intended to be submitted for assessment purposes.

Quantity requirements are intended to be minimum number of samples necessary to assess waters. This applies to both listing and delisting methodologies. For radioactivity (Section 6.5), toxic substances (Section 6.7), and ammonia (Section 6.12), an assessment of non-attainment can be achieved before reaching 10 samples because these parameters are not assessed based on a percentage for non-attainment purposes; they are assessed as "not attained" whenever an absolute threshold is reached. A minimum of 10 samples are still required to delist or to assess as "attains" for these three parameters.

Spatial requirements

Spatial requirements relate to where samples should be taken within the water body, if any particular requirements exist beyond Phase I requirements or QAPP requirements. As per Phase I

data requirements, all data must be characteristic of the main water mass or hydrologic area. Spatial requirements may also be spelled out in the QAPP accompanying the data.

Spatial requirements for lakes and reservoirs are intended to ensure assessment consistent with standards development. Primary contact recreation, secondary contact recreation, and the majority of lake aquatic life productivity occur in the epilimnion (uppermost stratified layer). For these reasons, Arkansas's water quality standards for lakes and reservoirs were developed using data collected within the epilimnion. If no epilimnion exists—due to natural depth limitations or seasonal mixing—samples should be taken between 0.33 and 2.0 meters of the surface unless otherwise noted within the Phase II quality requirements for a parameter.

6.0.2 Continuous data

For assessment purposes, both short-term and long-term continuous data taken in less than hourly readings (example: data recorded every fifteen minutes) will be calculated into hourly averages.

Short-term continuous data must span at least 90% of the 24-hour period to be used for that day. Long-term continuous data must span approximately 90% of the applicable temporal requirements.

6.1 TEMPERATURE

This section establishes the protocol for assessment of temperature criteria within Arkansas's surface waters, per APC&EC Rule 2.502:

The following standards are applicable:

Waterbodies	***Limit ˚C (˚F)***
Streams	
Ozark Highlands	*29 (84.2)*
Boston Mountains	*31 (87.8)*
Arkansas River Valley	*31 (87.8)*
Ouachita Mountains	*30 (86.0)*
Springwater-influenced Gulf Coastal	*30 (86.0)*
Typical Gulf Coastal	*30 (86.0)*
Least-Altered Delta	*30 (86.0)*
Channel-Altered Delta	*32 (89.6)*
White River (Dam #1 to mouth)	*32 (89.6)*
St. Francis River	*32 (89.6)*
Mississippi River	*32 (89.6)*
Arkansas River	*32 (89.6)*
Ouachita River (L. Missouri to Louisiana state line)	*32 (89.6)*
Red River	*32 (89.6)*
Lakes and Reservoirs	*32 (89.6)*
Trout Waters	*20 (68.0)*

PHASE II DATA QUALITY REQUIREMENTS FOR TEMPERATURE

Both discrete and long-term continuous data can be considered for temperature assessment of all waters.

Temperature – Trout Waters – Lakes and Streams

1. Temporal requirements

- Discrete and long-term continuous data
  - Collected year round

2. Minimum distribution and quantity requirements

- Discrete data
  - A minimum of 10 samples.
  - Evenly distributed over at least 2 years and 3 quarters per year.
- Long-term continuous data
  - Covers 10 months of a 12-month period.
  - Collected at least hourly.

3. Spatial requirements

- For streams and rivers, none that are not already covered in Phase I requirements.
- For lakes and reservoirs, samples are to be taken within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

Temperature – Non-Trout Waters – Streams and Rivers

1. Temporal requirements

- Discrete Data
  - Collected year round.
- Long-Term Continuous Data
  - Data should be collected during the critical season.
    - Critical season is defined, in Rule 2, as that time of year when water temperatures naturally exceed 22 degrees Celsius for the given AU.
    - Only data above 22 degrees Celsius will be utilized for assessments made using long-term continuous data.

2. Minimum distribution and quantity requirements

- Discrete Data
  - A minimum of 10 samples.
  - Evenly distributed over at least 2 and 3 quarters per year.
- Long-Term Continuous Data
  - Evenly distributed throughout the critical season
  - Collected at least hourly.

3. Spatial requirements

- None that are not already covered in Phase I requirements.

Temperature – Non-Trout Waters – Lakes and Reservoirs

1. Temporal requirements

- Discrete Data
  - Collected year round.
- Long-Term Continuous Data
  - Collect during the critical season.
    - Critical season is defined, in Rule 2, as that time of year when water temperatures naturally exceed 22 degrees Celsius for the given AU.
    - Only data above 22 degrees Celsius will be utilized for assessments made using long-term continuous data.

2. Minimum distribution and quantity requirements

- Discrete data
  - A minimum of 10 quarterly samples.
- Long-term Continuous Data
  - Evenly distributed throughout the critical season.
  - Collected at least hourly

3. Spatial requirements

- Take samples within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

ASSESSMENT METHODOLOGY FOR TEMPERATURE

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2; however, differing data types (discrete and long-term continuous) will not be combined. Refer to Section 3.11 for information regarding final attainment decisions should both types of data exist for an AU. Temperature assessments can be made using long-term continuous data measured for only one critical season; however; if multiple critical season data sets exist from different years, within the period of record, data sets will be combined. Continuous data will be calculated to hourly average for assessment purposes. Binomial distribution method will be applied for temperature data assessments, per Section 3.6.

LISTING METHODOLOGY:

Stream, river, lake and reservoir AUs may be assessed as non-attainment when, using the **10% exceedance rate** within Table 1, greater than or equal to the minimum number of samples allowed for the entire qualifying data set exceed the applicable temperature criteria listed in Rule 2.502 (or site specific in Rule 2's Appendix A). This methodology applies to both discrete and long-term continuous data sets.

DELISTING METHODOLOGY:

Stream, river, lake and reservoir AUs may be assessed as support when, using the **10% exceedance rate** within Table 2, no more than the maximum number of samples allowed for the entire qualifying data set exceed the applicable temperature criteria listed in Rule 2.502 (or site specific in Appendix A). This methodology applies to both discrete and long-term continuous data sets.

In some instances, DEQ may use discrete data to delist AUs that were listed using continuous data, and vice versa. However, this will not be the rule, it will be the exception. When this

occurs, justification of use of a different type of data for delisting will be provided within the 305(b) report as well as submitted with the 303(d) list for public notice and any supporting documentation will be provided. Justification for this methodology could include limited data availability, inability to acquire the same type of data that was used to list, or other special circumstances.

6.2 TURBIDITY

This section establishes the protocol for assessment of turbidity criteria within Arkansas's surface waters, per APC&EC Rule 2.503:

> *There shall be no distinctly visible increase in turbidity of receiving waters attributable to discharges or instream activities. The values below should not be exceeded during base flow (June to October) in more than 20% of samples. The values below should not be exceeded during storm flows in more than 25% of samples taken in not less than 24 monthly samples.*

Waterbodies	***Base Flows Values (NTU)***	***Storm Flow Values (NTU)***
Streams		
Ozark Highlands	*10*	*17*
Boston Mountains	*10*	*19*
Arkansas River Valley	*21*	*40*
Ouachita Mountains	*10*	*18*
Springwater-influenced Gulf Coastal	*21*	*32*
Typical Gulf Coastal	*21*	*32*
Least-Altered Delta	*45*	*84*
Channel-Altered Delta	*75*	*250*
Arkansas River	*50*	*52*
Mississippi River	*50*	*75*
Red River	*50*	*150*
St. Francis River	*75*	*100*
Trout	*10*	*15*
Lakes and Reservoirs	*25*	*45*

PHASE II DATA QUALITY REQUIREMENTS FOR TURBIDITY

Turbidity assessments can be made with discrete data collected in Nephelometric Turbidity Units (NTU) only. Data collected in Formazin Nephelometric Units (FNU) will be used for screening purposes only.

Turbidity Base Flow – Streams and Rivers

Base flows season is defined, in Rule 2, as June to October.

1. Temporal requirements
- Collect during base flow season.

2. Minimum distribution and quantity requirements
- A minimum of 10 samples.
- Evenly distributed throughout the base flows season.
- Collected over at least 2 seasons.

3. Spatial requirements
- None that are not already covered in Phase I requirements.

Turbidity Base Flow – Lakes and Reservoirs

Base flow season is defined, in Rule 2, as June to October.

1. Temporal requirements
- Collect during base flows season.

2. Minimum distribution and quantity requirements
- A minimum of 5 samples.
- Evenly distributed over at least 3 years.

3. Spatial requirements
- Take samples within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

Turbidity Storm Flow –All Waters

Storm flows season is defined, in Rule 2, as year round.

1. Temporal requirements
- Collect year round.

2. Minimum distribution and quantity requirements
- No less than 24 monthly samples are required.

3. Spatial requirements
- For lakes and reservoirs, take samples within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.
- For streams and rivers, none that are not already covered in Phase I requirements.

ASSESSMENT METHODOLOGY FOR TURBIDITY

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2. Discrete samples from multiple base flows seasons within the period of record (if exist) will be combined for assessments. If an AU is assessed as not meeting either the base flow or storm flow values, or both, it may be listed as non-attainment for turbidity. Binomial distribution method will be applied to turbidity data, per Section 3.6.

BASE FLOWS LISTING METHODOLOGY:

Stream, river, lake and reservoir AUs may be assessed as non-attainment when, using the **20% exceedance rate** within Table 1, greater than or equal to the minimum number of samples for the entire qualifying data set from June to October exceed the applicable base flows values listed in APC&EC Rule 2.503.

BASE FLOWS DELISTING METHODOLOGY:

Stream, river, lake and reservoir AUs may be assessed as in attainment when, using the **20% exceedance rate** in Table 2, no more than the maximum number of samples allowed for the entire qualifying data set from June to October exceed the applicable base flows values listed in APC&EC Rule 2.503.

STORM FLOWS LISTING METHODOLOGY:

Stream, river, lake and reservoir AUs may be assessed as non-attainment when, using the **25% exceedance rate** within Table 1, greater than or equal to the minimum number of samples for the entire qualifying data set (sample set not to be fewer than 24 data points) exceed the applicable storm flows values listed in APC&EC Rule 2.503.

STORM FLOWS DELISTING METHODOLOGY:

Stream, river, lake and reservoir AUs may be assessed as in attainment when, using the **25% exceedance rate** in Table 2, no more than the maximum number of samples allowed for the entire qualifying data set (sample set not to be fewer than 24 data points) exceed the applicable storm flows values listed in APC&EC Rule 2.503.

6.3 PH

This section establishes the protocol for assessment of pH criteria within Arkansas's surface waters, per APC&EC Rule 2.504:

> *pH between 6.0 and 9.0 standard units are the applicable standards for streams.*

PHASE II DATA QUALITY REQUIREMENTS FOR pH

pH assessments can be made using discrete data, short-term continuous data, or long-term continuous data in streams and rivers; and discrete data and long-term continuous data in lakes and reservoirs.

pH – Streams and Rivers

1. Temporal requirements
- Collected year round.

2. Minimum distribution and quantity requirements
- Discrete Data
  - A minimum of 10 samples.
  - Evenly distributed over at least 2 years and 3 quarters per year.
- Short-term Continuous data
  - A minimum of 2 diel deployments of at least 48 hours each.
  - Taken at least 2 weeks apart.
  - The 2 diel deployments must be within the same year.
  - Collected at least hourly.
- Long-term Continuous Data
  - Covers 10 months of a 12-month period.
  - Collected at least hourly.

3. Spatial requirements
- None that are not already covered in Phase I requirements.

pH – Lakes and Reservoirs

1. Temporal requirements
- Collected year round.

2. Minimum distribution and quantity requirements
- Discrete Data
  - A minimum of 10 quarterly samples.
- Short-term Continuous data
  - A minimum of 2 diel deployments of at least 48 hours each.
  - Taken at least 2 weeks apart.
  - The 2 diel deployments must be within the same year.
  - Collected at least hourly.
- Long-Term Continuous Data
  - Covers 10 of the 12-month period.
  - collected at least hourly.

3. Spatial requirements

- Take samples within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

ASSESSMENT METHODOLOGY FOR pH

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2; however, differing data types (discrete, short-term continuous, and long-term continuous) will not be combined. Refer to Section 3.8 for information regarding final attainment decisions should more than one type of data set exist for an AU. Binomial distribution method will be applied to pH data, per Section 3.6.

LISTING METHODOLOGY:

Stream, river, lake and reservoir AUs may be assessed as non-attainment when, using the **10% exceedance rate** in Table 1, greater than or equal to the minimum number of samples for the entire qualifying data set exceed the applicable pH criteria listed in APC&EC Rule 2.504. This methodology applies to discrete, short-term continuous, and long-term continuous data.

DELISTING METHODOLOGY:

Stream, river, lake and reservoir AUs may be assessed as attainment when, using the **10% exceedance rate** within Table 2, no more than the maximum number of samples allowed for the entire qualifying data set exceed the applicable pH criteria listed in APC&EC Rule 2.504. This methodology applies to discrete, short-term continuous, and long-term continuous data.

In some instances, DEQ may use discrete data to delist AUs that were listed using continuous data, and vice versa. However, this will not be the rule, it will be the exception. When this occurs, justification of use of a different type of data for delisting will be provided within the 305(b) Report as well as submitted with the 303(d) list for public notice and any supporting documentation will be provided. Justification for this methodology could include limited data availability, inability to acquire the same type of data that was used to list, or other special circumstances.

6.4 DISSOLVED OXYGEN

This section establishes the protocol for assessment of dissolved oxygen criteria within Arkansas's surface waters, per APC&EC Rule 2.505 and any site specific dissolved oxygen criteria within Appendix A of Rule 2:

Rivers and Streams

The following dissolved oxygen standards must be met:

Waterbodies	***Limit (mg/L)***	
Streams	*Primary*	*Critical*
Ozark Highlands		
<10 mi^2 watershed	*6*	*2*
10 to 100 mi^2	*6*	*5*
>100 mi^2 watershed	*6*	*6*
Boston Mountains		
<10 mi^2 watershed	*6*	*2*
>10 mi^2 watershed	*6*	*6*
Arkansas River Valley		
<10 mi^2 watershed	*5*	*2*
10 mi^2 to 150 mi^2	*5*	*3*
151 mi^2 to 400 mi^2	*5*	*4*
>400 mi^2 watershed	*5*	*5*
Ouachita Mountains		
<10 mi^2 watershed	*6*	*2*
>10 mi^2 watershed	*6*	*6*
Typical Gulf Coastal		
<10 mi^2 watershed	*5*	*2*
10 mi^2 to 500 mi^2	*5*	*3*
>500 mi^2 watershed	*5*	*5*
Springwater-influenced Gulf Coastal		
All size watersheds	*6*	*5*
Delta (least-altered and channel altered)		
<10 mi^2 watershed	*5*	*2*
10 mi^2 to 100 mi^2	*5*	*3*
>100 mi^2 watershed	*5*	*5*
Trout Waters		
All size watersheds	*6*	*6*

Lakes and Reservoirs

Specific dissolved oxygen standards for lakes and reservoirs shall be 5 mg/L.

In streams with watersheds of less than 10 mi^2, it is assumed that insufficient water exists to support a fishery during the critical season. During this time, a dissolved oxygen standard of

2 mg/l will apply to prevent nuisance conditions. However, field verification is required in areas suspected of having significant groundwater flows or enduring pools which may support unique aquatic biota. In such waters the critical season standard for the next size category of stream shall apply.

All streams with watersheds of less than 10 mi^2 are expected to support aquatic life during the primary season when stream flows, including discharges, equal or exceed 1 cubic foot per second (cfs). However, when site verification indicates that aquatic life exists at flows below 1 cfs, such aquatic biota will be protected by the primary standard (refer to the State of Arkansas Continuing Planning Process for field verification requirements).

Also, in these streams with watersheds of less than 10 mi^2, where waste discharges are 1 cfs or more, they are assumed to provide sufficient water to support aquatic life and, therefore, must meet the dissolved oxygen standards of the next size category of streams.

PHASE II DATA QUALITY REQUIREMENTS FOR DISSOLVED OXYGEN

Assessments for dissolved oxygen can be made using discrete data, short-term continuous data, or long-term continuous data depending on season. Concurrent temperature data must accompany dissolved oxygen data to be used for assessments.

Dissolved Oxygen - Trout Waters

1. Temporal requirements
   - Discrete data and long-term continuous data
     - Collected year round.
   - Short-term continuous data
     - Collected during the critical season.

2. Minimum distribution and quantity requirements
   - Discrete data
     - A minimum of 10 discrete sample.
     - Evenly distributed over at least 2 years and 3 quarters per year.
   - Short-term continuous data
     - A minimum of 2 diel deployments of no less than 48 hours each.
     - Taken at least two weeks apart.
     - The two diel deployments must be within the same year.
     - Collected at least hourly.
   - Long-term continuous data
     - Cover 10 months of a 12-month period.
     - Collected at least hourly.

3. Spatial requirements
   - For streams and rivers, none that are not already covered in Phase I requirements.
   - For lakes and reservoirs, samples are to be taken within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

Dissolved Oxygen - Non-Trout Waters

Primary Season – Streams and Rivers

1. Temporal requirements

- Discrete, short-term, and long-term continuous data
  - Collected during the primary season.
    - "Primary season" is defined as the time of year when water temperatures are less than or equal to 22 degrees Celsius.

2. Minimum distribution and quantity requirements

- Discrete data
  - A minimum of 10 discrete samples.
  - Evenly distributed over at least 2 primary seasons.
- Short-term continuous
  - A minimum of 2 diel deployments of no less than 48 hours each.
  - Taken at least two weeks apart
  - The 2 diel deployments must be within the same year.
  - Collected at least hourly.
- Long-term continuous data
  - Evenly distributed throughout the primary season.
  - Collected at least hourly.

3. Spatial requirements

- None that are not already covered in Phase I requirements.

Dissolved Oxygen – Non-Trout Waters

Critical Season – Streams and Rivers

1. Temporal requirements

- Discrete, short-term, and long-term continuous data
  - Collected during the critical season.
    - "Critical season" is defined as the time of year when water temperatures are greater than 22 degrees Celsius.

2. Minimum distribution and quantity requirements

- Discrete data
  - A minimum of 10 discrete samples.
  - Evenly distributed over at 2 seasons.
- Short-term continuous data
  - A minimum of 2 diel deployments of no less than 48 hours each.
  - Taken at least 2 weeks apart.
  - The 2 diel deployments must be within the same year.
  - Collected at least hourly.
  - At least 90% of the paired temperature for the entire dataset is > 22 ^{o}C.
- Long-term continuous data
  - Evenly distributed throughout the critical season.
  - Collected at least hourly.
  - At least 90% of the paired temperature for the entire dataset is > 22 ^{o}C.

3. Spatial requirements

- None that are not already covered in Phase I requirements.
-

Dissolved Oxygen – Non-Trout Waters
Lakes and Reservoirs

1. Temporal requirements

- Discrete, short-term continuous and long-term continuous data
  - Collected year round.

2. Minimum distribution and quantity requirements

- Discrete data
  - A minimum of 10 quarterly samples.
- Short-term continuous data
  - A minimum of 2 diel deployments of no less than 48 hours each.
  - The two diel deployments must be within the same year
  - Collected at least hourly.
- Long-term continuous data
  - Covers 10 months of a 12-month period.
  - Collected at least hourly.

3. Spatial requirements

- Taken within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

ASSESSMENT METHODOLOGY FOR DISSOLVED OXYGEN

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2; however, differing data types (discrete, short-term continuous, and long-term continuous) will not be combined. Refer to Section 3.8 for information regarding final attainment decisions should more than one type of data set exist for an AU. Concurrent temperature data must accompany dissolved oxygen data for attainment decisions. Binomial distribution method will be applied to all data types of dissolved oxygen data, per Section 3.6. If long term continuous data sets do not meet requirements for long term assessments, they may be used to assess critical season if they meet short term data requirements. Continuous data sets will be calculated into hourly averages.

LISTING METHODOLOGY:

Stream, river, lake and reservoir AUs may be assessed as non-attainment when, using the **10% exceedance rate** within Table 1, greater than or equal to the minimum number of samples for the entire qualifying data set fail to meet the minimum applicable dissolved oxygen criteria listed in APC&EC Rule 2.505 (or site specific in Appendix A) for either the primary or critical season, or year-round, as appropriate. This methodology applies to discrete, short-term continuous, and long-term continuous data.

DELISTING METHODOLOGY:

Stream, river, lake, and reservoir AUs may be assessed as attainment when, using the **10% exceedance rate** within Table 2, no more than the maximum number of samples allowed for the entire qualifying data set fail to meet the applicable dissolved oxygen criteria listed in APC&EC

Rule 2.505 (or site specific in Appendix A) for either the primary or critical season, or year-round as appropriate. This methodology applies to discrete, short-term continuous, and long-term continuous data.

In some instances, DEQ may use discrete data to delist AUs that were listed using continuous data, and vice versa. However, this will not be the rule, it will be the exception. When this occurs, justification of use of a different type of data for delisting will be provided within the 305(b) report as well as submitted with the 303(d) list for public notice and any supporting documentation will be provided. Justification for this methodology could include limited data availability, inability to acquire the same type of data that was used to list, or other special circumstances.

6.5 RADIOACTIVITY

This section establishes the protocol for assessment of radioactivity criteria within Arkansas's surface waters, per APC&EC Rule 2.506:

> *The Rules for the Control of Sources of Ionizing Radiation of the Division of Radiological Health, Arkansas Department of Health, limits the maximum permissible levels of radiation that may be present in effluents to surface waters in uncontrollable areas. These limits shall apply for the purposes of these standards, except that in no case shall the levels of dissolved radium-226 and strontium-90 exceed 3 and 10 picocuries/liter, respectively, in the receiving water after mixing, nor shall the gross beta concentration exceed 1000 picocuries/liter.*

PHASE II DATA QUALITY REQUIREMENTS FOR RADIOACTIVITY

Assessments for radioactivity will be made using discrete data only.

1. Temporal requirements
   - Collected year round.

2. Minimum distribution and quantity requirements:
   - A minimum of 10 samples unless an assessment of non-attainment can be reached in fewer than 10 samples.
   - For streams and rivers, evenly distributed over at least 2 years and 3 quarters per year; unless an assessment of non-attainment can be reached in fewer than 10 samples.
   - For lakes and reservoirs, 10 quarterly samples over not less than 3 years; unless an assessment of non-attainment can be reached in fewer than 10 samples.

3. Spatial requirements
   - None that are not already covered in Phase I requirements.

ASSESSMENT METHODOLOGY FOR RADIOACTIVITY

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2.

LISTING METHODOLOGY:

Stream, river, lake and reservoir AUs may be assessed as non-attainment when a **single sample within the period of record exceeds** the concentration of 3 picocuries/Liter for radium-226, or the concentration of 10 picocuries/Liter for strontium-90, or if the gross beta concentration exceeds 1000 picocuries/liter per APC&EC Rule 2.506, even if the minimum of 10 samples has not been reached.

DELISTING METHODOLOGY:

Stream, river, lake and reservoir AUs may be assessed as attainment when no **samples in the period of record exceed** the concentration of 3 picocuries/Liter for radium-226, or the concentration of 10 picocuries/Liter for strontium-90, or if the gross beta concentration does not exceeds 1000 picocuries/liter per APC&EC Rule 2.506. A minimum of 10 samples must be reached to make an assessment of attainment.

6.6 BACTERIA

This section establishes the protocol for assessment of bacteria criteria within Arkansas's surface waters, per APC&EC Rule 2.507:

For the purposes of this rule, all streams with watersheds less than 10 mi^2 shall not be designated for primary contact unless and until site verification indicates that such use is attainable. No mixing zones are allowed for discharges of bacteria.

For assessment of ambient waters as impaired by bacteria, the below listed applicable values for E. coli shall not be exceeded in more than 25% of samples in no less than eight (8) samples taken during the primary contact season or during the secondary contact season.

The following standards are applicable:

Contact Recreation Seasons	***Limit (col/100mL)***			
Primary Contact[1]	*E. coli*		*Fecal Coliform*	
	IS[3]	*GM[4]*	*IS[3]*	*GM[4]*
ERW, ESW, NSW, Reservoirs, Lakes	*298*	*126*	*400*	*200*
All Other Waters	*410*	*NA*	*400*	*200*
Secondary Contact[5]				
ERW, ESW, NSW, Reservoirs, Lakes[2]	*1490*	*630*	*2000*	*1000*
All Other Waters	*2050*	*NA*	*2000*	*1000*

[1] May 1 to September 30
[3] For assessment of Individual Sample Criteria– at least eight (8) data points
[4] For calculation and assessment of Geometric Mean – calculated on a minimum of five (5) samples spaced evenly and within a thirty (30)-day period.
[5] Year-round.

The Arkansas Department of Health has the responsibility of approving or disapproving surface waters for public water supply and of approving or disapproving the suitability of specifically delineated outdoor bathing places for body contact recreation, and it has issued rules and regulations pertaining to such uses.

PHASE II DATA QUALITY REQUIREMENTS FOR BACTERIA

Bacterial assessments are made with discrete *Escherichia coli* (*E. coli*) data. In the absence of *E. coli* data, discrete fecal coliform data may be utilized.

Bacteria – Primary Contact Season

1. Temporal requirements

- Collected during the primary contact season.
  - The primary contact season is defined, in Rule 2, as May 1 to September 30.

2. Minimum distribution and quantity requirements

- Individual Samples

- A minimum of 1 primary contact season.
- A minimum of 8 discrete samples per primary contact season.
- Evenly distributed within the primary contact season

- Geometric Mean
  - A minimum of 5 samples.
  - Evenly distributed within a 30-day period.

3. Spatial Requirements

- Individual Samples
  - None that are not already covered in Phase I requirements.
  - For lakes and reservoirs, samples are to be taken within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.
- Geometric Mean
  - *E. coli* - Applicable for assessments only in ERW, ESW, NSW waters; lakes; and reservoirs.
  - Fecal Coliform – Applicable for assessments in all waters
  - For lakes and reservoirs, samples are to be taken within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

Bacteria - Secondary Contact Season

1. Temporal requirements

- Collected during the secondary contact season.
  - The secondary contact season is defined, in Rule 2, as year-round.

2. Minimum data distribution and quantity requirements

- Individual Samples
  - A minimum of 1 secondary contact season.
  - A minimum of 8 discrete samples per secondary contact season.
  - Evenly distributed within the secondary contact season.
- Geometric Mean
  - A minimum of 5 samples.
  - Evenly distributed within a 30-day period.

3. Spatial Requirements

- Individual Samples
  - None that are not already covered in Phase I requirements.
  - For lakes and reservoirs, samples are to be taken within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.
- Geometric Mean
  - *E. coli* - Applicable for assessments only in ERW, ESW, NSW waters; lakes; and reservoirs.
  - For lakes and reservoirs, samples are to be taken within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

ASSESSMENT METHODOLOGY FOR BACTERIA

Bacterial assessments are made with discrete *E. coli* data. In the absence of *E. coli* bacteria data, fecal coliform bacteria data may be utilized for assessments. Bacterial assessments are made with

discrete data only. Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2. Data in most probable number (MPN) units will be evaluated for use in assessments of *E. coli*.

Assessments can be made using individual samples or geometric mean (as appropriate per spatial requirements described above). If adequate data sets exist for both single sample and geometric mean assessment (within the same year), both methods will be assessed separately and the most protective result will be used as the final assessment decision.

The binomial distribution method will not be applied. A straight mathematical 25% exceedance rate will be used to assess attainment (Example: 2 exceedances in 8 samples equal 25%).

For assessment of ambient waters using bacteria:

- Primary Contact
  - Individual Samples - Assessments can be made using data from only one primary contact season within the period of record. However, if complete data sets exist for more than one primary contact season within the period of record, data sets will be combined for assessment. Each primary season must contain 8 evenly distributed samples (per Phase II requirements above). Primary contact seasons with fewer than 8 samples will not be combined with data from other primary contact seasons and will not be used for assessment purposes.
  - Geometric Mean - All geometric means calculated for any primary contact season within the period of record will be considered for assessment purposes. All samples within a 30-day period that meet the "evenly spaced" requirement must be used for geometric mean calculation.

- Secondary Contact
  - Individual Samples - Assessments can be made using data from only one secondary contact season within the period of record. However, if complete data sets exist for more than one secondary contact season within the period of record, data sets will be combined for assessment. Each secondary season must contain 8 evenly distributed samples (per Phase II requirements above). Secondary contact seasons with fewer than 8 samples will not be combined with data from other secondary contact seasons and will not be used for assessment purposes.
  - Geometric Mean - All geometric means calculated for any secondary contact season within the period of record will be considered for assessment purposes. All samples within a 30-day period that meet the "evenly spaced" requirement must be used for geometric mean calculation. Example: If daily readings exist for a 30-day period, all 30 readings must be used, not just any 5 or more of those readings.

LISTING METHODOLOGY:

Individual Samples

Stream, river, reservoir, and lake AUs may be assessed as non-support when the applicable criteria is exceeded in **greater than 25%** of samples collected during months within the applicable contact season (as described above).

If the assessment of non-support is based on only 1 season of data, (8 discrete samples within one primary contact season, or within one secondary contact season), the AU may be placed in Category 3 and more data may be collected for re-assessment in a future assessment cycle.

If the assessment of non-support is based on more than one season of data, the AU will be placed in Category 5, truly impaired.

Geometric Mean

Stream, river, lake and reservoir AUs may be assessed as non-support **when the geometric mean for the applicable contact season is exceeded**. If one or more geometric mean calculations within the season exceed the criteria the AU may be assessed as non-support.

DELISTING METHODOLOGY:

Individual Samples

Stream, river, lake and reservoir AUs may be assessed as support when the applicable criteria is **exceeded in 25%or less** of samples collected during months within the applicable contact season (as described above). This assessment result will apply for single season and multi-season assessments.

Geometric Mean

Stream, river, lake and reservoir AUs may be assessed as support **when the geometric mean for the applicable contact season is not exceeded**. If more than one geometric mean calculation exists, all must not exceed the criteria.

Table 8: Statewide bacteria assessment criteria.

	Escherichia coli	CRITERIA	SUPPORT	NON-SUPPORT
PRIMIMARY CONTACT	ERW, ESW, and NSW Waters Lakes, Reservoirs	GM 126 col/100 mL*	≤ criteria	> criteria
		298 col/100 mL (May-Sept)	≤ 25% exceedance	>25% exceedance
	All other waters	410 col/100 mL (May-Sept)	≤ 25% exceedance	>25% exceedance
SECONDARY CONTACT	ERW, ESW, and NSW Waters Lakes, Reservoirs	GM 630 col/100 mL*	≤ criteria	> criteria
		1490 col/100 mL (Oct. - April)	≤ 25% exceedance	>25% exceedance
	All other waters	2050 col/100 mL (Oct. - April)	≤ 25% exceedance	>25% exceedance

ERW: Extraordinary Resource Water, **NSW**: Natural and Scenic Waterway, **ESW**: Ecologically Sensitive Water

*Geometric mean can be calculated for any 30-day period within a season (primary season May 1 through September 30; secondary season year-round).

6.7 TOXIC SUBSTANCES

This section establishes the protocol for assessment of toxic substances criteria within Arkansas's surface waters, per APC&EC Rule 2.508:

> *Toxic substances shall not be present in receiving waters, after mixing, in such quantities as to be toxic to human, animal, plant or aquatic life or to interfere with the normal propagation, growth and survival of the indigenous aquatic biota. For non-permit issues and as a guideline for evaluating toxic substances not listed in the following tables, the Division may consider No Observed Effect Concentrations or other literature values as appropriate. For the substances listed below, the following standards shall apply:*

ALL WATERBODIES - AQUATIC LIFE CRITERIA

Substance	***Acute Values (µg/L)***	***Chronic Values (µg/L)***
		(24-hr Average)
PCBs		*0.0140*
Aldrin	*3.0*	
Dieldrin	*2.5*	*0.0019*
DDT (& metabolites)	*1.1*	*0.0010*
*Endrin**	*0.18*	*0.0023*
Toxaphene	*0.73*	*0.0002*
Chlordane	*2.4*	*0.0043*
*Endosulfan**	*0.22*	*0.056*
Heptachlor	*0.52*	*0.0038*
*Hexachlorocyclohexane**	*2.0*	*0.080*
Pentachlorophenol	$e^{[1.005(pH)-4.869]}$	$e^{[1.005(pH)-5.134]}$
Chlorpyrifos	*0.083*	*0.041*

** Total of all isomers*

*DISSOLVED METALS**

	Acute Criteria (CMC) - µg/L(ppb)		***Chronic Criteria (CCC) - µg/L(ppb)***	
Substance	***Formula X***	***Conversion***	***Formula X***	***Conversion***
Cadmium	$e^{[1.128(\ln hardness)]-3.828}$	*(a)*	$e^{[0.7852(\ln hardness)]-3.490}$	*(c)*
Chromium(III)	$e^{[0.819(\ln hardness)]+3.688}$	*0.316*	$e^{[0.8190(\ln hardness)]+1.561}$	*0.860*
Chromium (VI)	*16*	*0.982*	*11*	*0.962*
Copper	$e^{[0..9422(\ln hardness)]-1.464}$	*0.960*	$e^{[0.8545(\ln hardness)]-1.465}$	*0.960*
Lead	$e^{[1.273(\ln hardness)]-1.460}$	*(b)*	$e^{[1.273(\ln hardness)]-4.705}$	*(b)*
Mercury	*2.4*	*0.85*	*0.012***	*NONE*
Nickel	$e^{[0.8460(\ln hardness)]+3.3612}$	*0.998*	$e^{[0.8460(\ln hardness)]+1.1645}$	*0.997*
*Selenium***	*20*	*NONE*	*5*	*NONE*
Silver	$e^{[1.72(\ln hardness)]-6.52}$	*0.85*	----------	*NONE*
Zinc	$e^{[0.8473(\ln hardness)]+0.8604}$	*0.978*	$e^{[0.8473(\ln hardness)]+0.7614}$	*0.986*
*Cyanide***	*22.36*	*NONE*	*5.2*	*NONE*

**These values may be adjusted by a site specific Water Effects Ratio (WER) as defined in 40 CFR Part 131.36 (c).*

(a) Calculated as: 1.136672 - [(ln hardness)(0.041838)]

(b) Calculated as: 1.46203 - [(ln hardness)(0.145712)]

(c) Calculated as: 1.101672 - [(ln hardness)(0.041838)]

***Expressed as total recoverable. Mercury based on bioaccumulation of residues in aquatic organisms, rather than toxicity.*

ALL WATERBODIES - HUMAN HEALTH CRITERIA

Substance	***Criteria (ng/L)****
Dioxin (2,3,7,8 TCDD)	*0.001*
Chlordane	*5.0*
PCBs (polychlorinated biphenyls)	*0.4*
alpha Hexachlorocyclohexane	*37.3*
Beryllium	*4000***
Dieldrin	*1.2*
Toxaphene	*6.3*

** Criteria based on a lifetime risk factor of 10^{-5}.*

***4000 ng/l is also represented as 4.0 ug/l, which is the Maximum contaminant level (MCL) under the EPA Safe Drinking Water Act [40 U.S.C. s/s 300f et seq. (1974)]*

PHASE II DATA QUALITY REQUIREMENTS FOR TOXICS

Only discrete data will be used to make attainment decisions regarding toxicity. Concurrent instream hardness data must accompany metals data for metals toxicity attainment decisions.

Toxics - Streams and Rivers

1. Temporal requirements
   - Collected year round

2. Data distribution and quantity requirements
   - A minimum of 10 samples unless an assessment of non-attainment can be reached in fewer than 10 samples.
   - Evenly distributed over at least 2 years and 3 quarters per year; unless an assessment of non-attainment can be reached in fewer than 10 samples.

3. Spatial requirements
   - None that are not already covered in Phase I requirements.

Toxics - Lakes and Reservoirs

1. Temporal requirements
   - Collect toxics data quarterly, at a minimum.

2. Minimum distribution and quantity requirements
   - A minimum of 10 quarterly samples unless an assessment of non-attainment can be reached in fewer than 10 samples.

3. Spatial requirements
   - Take samples within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

ASSESSMENT METHODOLOGY FOR TOXIC SUBSTANCES

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2. Metals toxicity will be evaluated based on instream hardness values at the time of sample collection. If the ambient hardness value is less than 25 mg/L, then a hardness value of 25 mg/L will be used to calculate metals toxicity.

LISTING METHODOLOGY:

Stream, river, lake and reservoir AUs may be assessed as non-support when **more than one (>1) exceedance** of the criterion, per APC&EC Rule 2.508, occurs during the period of record, even if the minimum of 10 samples has not been reached.

DELISTING METHODOLOGY:

Stream, river, lake and reservoir AUs may be assessed as support when there are **one or fewer (≤ 1) exceedances** of the criterion, per APC&EC Rule 2.508, during the period of record. A minimum of 10 samples must be reached to make an assessment of attainment.

6.8 FISH CONSUMPTION

This section establishes the protocol for determining attainment of fish consumption within Arkansas's surface waters.

ASSESSMENT METHODOLOGY FOR FISH CONSUMPTION

Fish consumption listings are based on fish consumption advisories issued by the Epidemiology Branch at Arkansas Department of Health.

LISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs will be listed as non-support for fish consumption if a primary segment of the fish community (e.g., all predators or all largemouth bass) **has restrictions for any group of people** (e.g., general population or high risk groups).

DELISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs will be listed as support if there **are no fish consumption restrictions or only a *limited consumption*** of fish is recommended (e.g., no more than 2 meals per month or no consumption of fish over 15 inches).

6.9 NUTRIENTS

This section establishes the protocol for assessment of nutrients within Arkansas's surface water, per APC&EC Rule 2.509:

> *(A) Materials stimulating algal growth shall not be present in concentrations sufficient to cause objectionable algal densities or other nuisance aquatic vegetation or otherwise impair any designated use of the waterbody. Impairment of a waterbody from excess nutrients is dependent on the natural waterbody characteristics such as stream flow, residence time, stream slope, substrate type, canopy, riparian vegetation, primary use of waterbody, season of the year and ecoregion water chemistry. Because nutrient water column concentrations do not always correlate directly with stream impairments, impairments will be assessed by a combination of factors such as water clarity, periphyton or phytoplankton production, dissolved oxygen values, dissolved oxygen saturation, diurnal dissolved oxygen fluctuations, pH values, aquatic-life community structure and possibly others. However, when excess nutrients result in an impairment, based upon Department assessment methodology, by any Arkansas established numeric water quality standard, the waterbody will be determined to be impaired by nutrients.*
>
> (*B)Site Specific Nutrient Standards*

Lake	*Chlorophyll a (ug/L)***	*Secchi Transparency (m)****
*Beaver Lake**	*8*	*1.1*

> **These standards are for measurement at the Hickory Creek site over the old thalweg, below the confluence of War Eagle Creek and the White River in Beaver Lake.*
> ***Growing season geometric mean (May - October)*
> ****Annual Average*

SCREENING REQUIREMENTS FOR NUTRIENTS

Discrete data will be used to screen total nitrogen (TN) and total phosphorus (TP). TN and TP data will be screened per respective ecoregion using the 75th percentile of TN and TP for the appropriate period of record. The 75th percentile should be calculated from all available TN/TP data that meet Phase 1 requirements. Combine fractions of TN/TP only if they were collected on the same day and the same AU

Phase I requirements. Data in each assessment unit for comparison against ecoregion values must meet the following requirements:

Nutrient Screening – Wadeable Streams

1. Temporal requirements
   - Collected year round
2. Data distribution and quantity requirements
   - A minimum of 10 samples
   - Evenly distributed over at least 1 year
3. Spatial requirements
   - None that are not already covered in Phase I requirements.

Arithmetic mean TN and TP concentrations for each AU will be compared to the 75th percentile screening values for the appropriate ecoregion and evaluated according to Figure 1.

PHASE II DATA QUALITY REQUIREMENTS FOR NUTRIENTS

Continuous and biological data requirements must be met for full nutrient assessment of impairment. Nutrient screenings will be made by calculating the average concentration of each site for the POR, which will be compared to the 75th percentile for that ecoregion. For purposes of nutrient assessment, a "year" is defined as a 12-month period.

Nutrients – Streams and Rivers

1. Temporal requirements:

- Short-term and long-term continuous pH or DO data
  - Collected within the critical season
    - Critical season is defined, in Rule 2, as that time of year when water temperatures naturally exceed 22 degrees Celsius for the given AU.
  - Paired with TN/TP data
- Biological communities
  - Fish communities must be collected during the same critical season as the continuous data.
  - Macroinvertebrate communities must be collected during the same year as fish collections, during either fall or spring base flow conditions.

2. Minimum distribution and quantity requirements

- Short-term continuous data
  - A minimum of 2 diel deployments of at least 48 hours each
  - Taken at least 2 weeks apart
  - The 2- diel deployments must be within the same year.
  - Collected at least hourly
- Long-term continuous data
  - Evenly distributed throughout the critical season
  - Collected at least hourly.
- Biological communities
  - A minimum of 1 fish community or 1 macroinvertebrate community data set per year.

3. Spatial and other requirements

- Short-term and long-term continuous pH or DO data
  - None that are not already covered in Phase 1 requirements.
- Biological communities
  - Collected in representative habitats of the AU.

Nutrients - Beaver Lake

1. Temporal requirements

- Secchi disk transparency
  - Collected year round.
- Chlorophyll *a*
  - Collected during the growing season.
    - Growing season is defined as May – October per Rule 2.509(B).

2. Minimum distribution and quantity requirements

- Secchi disk transparency
  - A minimum of 10 samples
  - Evenly distributed over 12 calendar months to calculate an annual average.
- Chlorophyll *a*
  - A minimum of 5 samples
  - Evenly distributed throughout the growing season
    - Growing season is defined as May – October per Rule 2.509(B).

3. Spatial requirements

- Secchi disk transparency and Chlorophyll *a*
  - All data shall be collected at the Hickory Creek site over the old thalweg, below the confluence of War Eagle Creek and the White River in Beaver Lake.
- Chlorophyll *a* sample depth shall not exceed 2 meters.

ASSESSMENT METHODOLOGY FOR NUTRIENTS

Assessment methodologies for nutrients have only been developed for, and only apply to, wadeable streams and Beaver Lake. Methodologies for wadeable streams were developed defining "wadeable" as fourth order streams and smaller using Strahler stream order (Strahler 1952). Site verification and best professional judgement was used to classify an AU as wadeable.

Nutrient assessment relies on "paired data." This means that physical, chemical, and biological data must be collected within the same year or season. Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2; however, differing data types (discrete, short-term continuous, and long-term continuous) will not be combined.

Beaver Lake Secchi disk readings and growing season chlorophyll *a* concentrations will be assessed per calendar year. If multiple chlorophyll *a* samples exist on the same day, but at the different depths, the most protective sample at each depth will be used for assessments.

LISTING METHODOLOGY FOR WADEABLE STREAMS:

Wadeable stream and river AUs will be listed as non-support for nutrients when the following conditions occur:

- The mean TP or TN concentration of the AU is greater than the 75th percentile of the TN or TP within an ecoregion, **and**
- When either the short-term or long-term data sets indicate at least pH or dissolved oxygen are exceeded (as per methodologies in Sections 6.3 and 6.4), **and**
- At least one biological community is evaluated as impaired.

Any wadeable stream or river segment that exceeds screening level criteria, but lacks adequate data to assess may be placed into Category 3b, Insufficient Data. Category 3 streams may be prioritized based on the magnitude of nutrient concentration, available data, and staff resources.

DELISTING METHODOLOGY FOR WADEABLE STREAMS:

- The mean TP or TN concentration of the AU is less than the 75th percentile of the TP or TN data from wadeable stream and river AUs within an ecoregion, **and**
- When neither the short-term or long-term datasets indicate pH or dissolved oxygen are not exceeded (as per methodologies in 6.3 and 6.4), **and**

- Biological communities used to make the listing are evaluated as unimpaired.

LISTING METHODOLOGY FOR BEAVER LAKE:

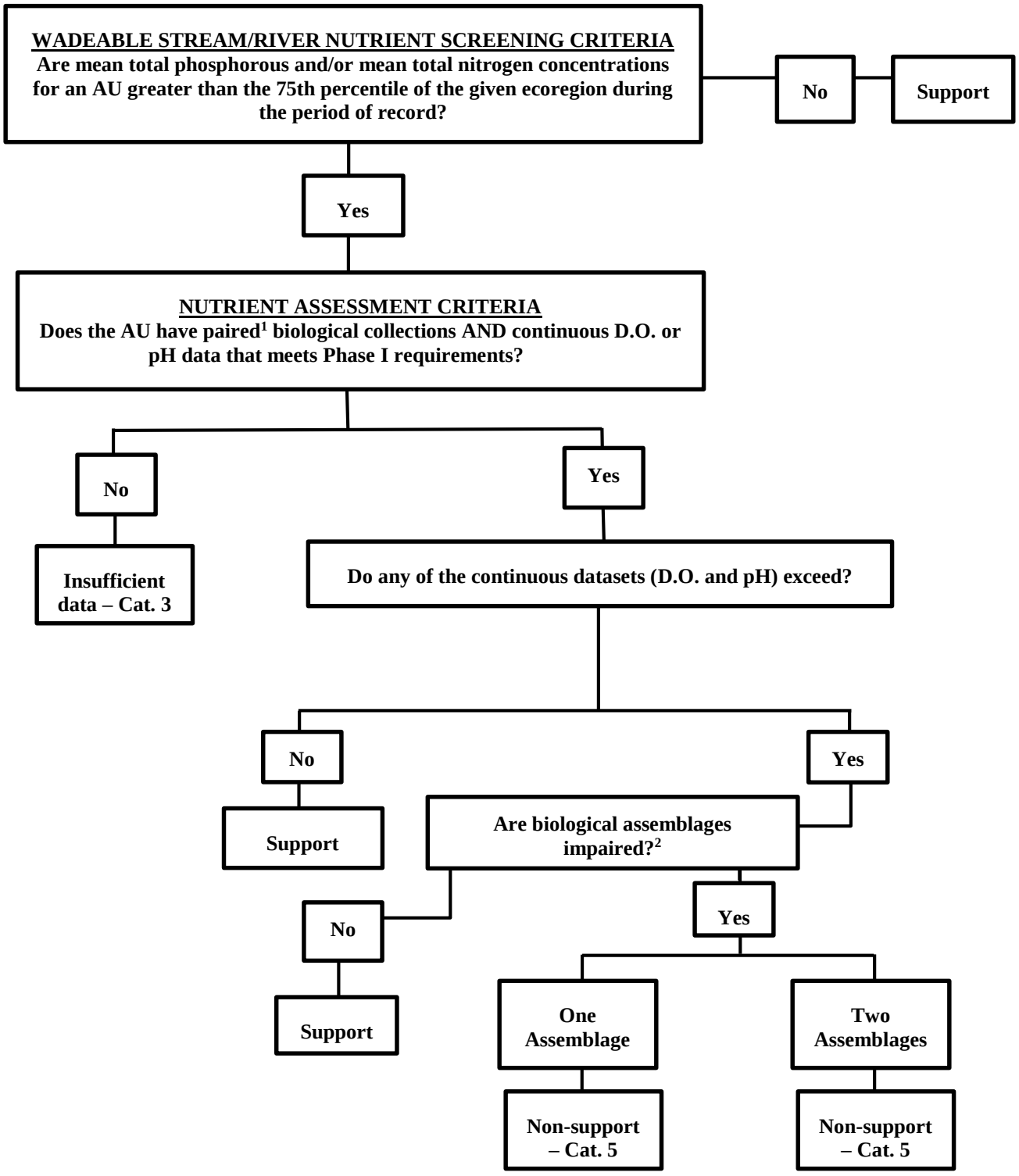
The Hickory Creek AU of Beaver Lake may be listed as non-support of its domestic water supply designated use when there are **three or more (≥3) geometric mean exceedances** of the chlorophyll *a* criteria within the five-year period of record.

The Hickory Creek AU of Beaver Lake may be listed as non-support of its domestic water supply designated use when there are **three or more (≥3) annual average exceedances** of the Secchi transparency criteria within the five-year period of record.

DELISTING METHODOLOGY FOR BEAVER LAKE:

The Hickory Creek AU of Beaver Lake may be listed as supporting its domestic water supply designated use when there **are no more than two (<=2) geometric mean exceedances of the chlorophyll *a* criteria *and* no more than two (<=2) annual averages exceedances** of the Secchi transparency criteria within the five-year period of record.

Figure 1: Nutrient assessment flowchart for wadeable streams and rivers



[1] Paired data/collections are defined as combined physical, chemical, and biological collections within the same calendar year and/or season.

[2] Section 5.0 discusses the determining factors for biological impairment.

6.10 SITE SPECIFIC MINERAL QUALITY

This section establishes the protocol for assessment of site specific mineral criteria within Arkansas's waters, per APC&EC Rule 2.511 (A):

> *(A) Site Specific Mineral Quality Criteria*
>
> *Mineral quality shall not be altered by municipal, industrial, other waste discharges or instream activities so as to interfere with designated uses. The following criteria apply to the streams indicated.*

PHASE II DATA QUALITY REQUIREMENTS FOR MINERALS

Minerals data (chloride, sulfates, TDS) will be used to assess site specific minerals. Only discrete data will be used.

Site Specific Minerals – Streams and Rivers

1. Temporal requirements
   - Collected year round.
2. Minimum distribution and quantity requirements
   - A minimum of 10 samples
   - Evenly distributed over at least 2 years and 3 quarters per year.
3. Spatial requirements
   - None that are not already covered in Phase I requirements.

Site Specific Minerals – Lakes and Reservoirs

1. Temporal requirements
   - Collected year round.
2. Minimum distribution and quantity requirements
   - A minimum of 10 quarterly samples.
3. Spatial requirements
   - Take samples within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters

ASSESSMENT METHODOLOGY FOR SITE SPECIFIC MINERAL QUALITY

Waters with site specific mineral criteria are assessed according to site specific values for chlorides, sulfates, and/or TDS listed in APC&EC Rule 2.511(A). Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2. Binomial distribution method will be applied to site specific mineral data, per Section 3.6.

LISTING METHODOLOGY:

Stream, river, lake and reservoir AUs with site specific mineral criteria may be assessed as non-support when, using the **25% exceedance rate** within Table 1, greater than or equal to the minimum number of samples for the entire qualifying data set exceed the applicable site specific mineral criteria listed in APC&EC Rule 2.511(A).

DELISTING METHODOLOGY:

Stream, river, lake and reservoir AUs with site specific mineral criteria may be assessed as support when, using the **25% exceedance rate** within Table 2, no more than the maximum number of samples allowed for the entire qualifying data set exceed the applicable site specific mineral criteria listed in APC&EC Rule 2.511(A).

6.11 NON-SITE SPECIFIC MINERAL QUALITY; AND DOMESTIC, AGRICULTURAL, AND INDUSTRIAL WATER SUPPLY USES

This section establishes the protocol for assessment of non-site specific mineral quality criteria and domestic water supply designated uses within Arkansas's surface waters, per APC&EC Rule 2.511(C):

> *(C) Domestic Water Supply Criteria*
>
> *In no case shall discharges cause concentrations in any waterbody to exceed 250, 250 and 500 mg/L of chlorides, sulfates and total dissolved solids, respectively, or cause concentrations to exceed the applicable criteria, except in accordance with Rules 2.306 and 2.308.*

This section is written in accordance with the Federal Safe Drinking Water Act (40 § C.F.R 143.3) and also establishes the protocol for assessing impairment due to exceedance of limits for agricultural and industrial water supplies.

PHASE II DATA QUALITY REQUIREMENTS FOR NON-SITE SPECIFIC MINERAL QUALITY; AND DOMESTIC, AGRICULTURAL, AND INDUSTRIAL WATER SUPPLY USES

Minerals data (chloride, sulfates, TDS) will be used to assess non-site specific minerals quality as well as Domestic, Agricultural, and Industrial Water Supply Uses. Only discrete data will be used.

Non-Site Specific Minerals - Streams and Rivers

1. Temporal requirements
   - Collected year round.
2. Minimum distribution and quantity requirements
   - A minimum of 10 samples
   - Evenly distributed over at least 2 years and 3 quarters per year.
3. Spatial requirements
   - None that are not already covered in Phase I requirements.

Non-Site Specific Minerals - Lakes and Reservoirs

1. Temporal requirements
   - Collected year round
2. Minimum distribution and quantity requirements
   - A minimum of 10 quarterly samples.
3. Spatial requirements
   - Take samples within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

ASSESSMENT METHODOLOGY FOR NON-SITE SPECIFIC MINERALS QUALITY; AND DOMESTIC, AGRICULTURAL, AND INDUSTRIAL WATER SUPPLY USE

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2. Binomial distribution method will be applied to non-site specific mineral data, as per Section 3.6.

LISTING METHODOLOGY:

Stream, river, lake and reservoir AUs may be assessed as non-support when, using the **10% exceedance rate** within Table 1, greater than or equal to the minimum number of samples for the entire qualifying data set exceed the applicable mineral criteria listed in APC&EC Rule 2.511(C).

DELISTING METHODOLOGY:

Stream, river, lake and reservoir AUs may be assessed as support when, using the **10% exceedance rate** within Table 2, no more than the maximum number of samples allowed for the entire qualifying data set exceed the applicable mineral criteria listed in APC&EC Rule 2.511(C).

6.12 AMMONIA

This section establishes the protocol for assessment of ammonia criteria in Arkansas's surface waters, per APC&EC Rule 2.512:

> *The total ammonia nitrogen (N) criteria and the frequency of occurrence are as follows:*
>
> *(A)The one-hour average concentration of total ammonia nitrogen shall not exceed, more than once every three years on the average, the acute criterion as shown in the following table:*

pH-Dependent Values of the CMC (Acute Criterion)- mg/L

pH	*Salmonids** *Present*	*Salmonids Absent*
6.5	*32.6*	*48.8*
6.6	*31.3*	*46.8*
6.7	*29.8*	*44.6*
6.8	*28.1*	*42.0*
6.9	*26.2*	*39.1*
7.0	*24.1*	*36.1*
7.1	*22.0*	*32.8*
7.2	*19.7*	*29.5*
7.3	*17.5*	*26.2*
7.4	*15.4*	*23.0*
7.5	*13.3*	*19.9*
7.6	*11.4*	*17.0*
7.7	*9.65*	*14.4*
7.8	*8.11*	*12.1*
7.9	*6.77*	*10.1*
8.0	*5.62*	*8.40*
8.1	*4.64*	*6.95*
8.2	*3.83*	*5.72*
8.3	*3.15*	*4.71*
8.4	*2.59*	*3.88*
8.5	*2.14*	*3.20*
8.6	*1.77*	*2.65*
8.7	*1.47*	*2.20*
8.8	*1.23*	*1.84*
8.9	*1.04*	*1.56*
9.0	*0.885*	*1.32*

** Family of fishes, which includes trout.*

(B) The monthly average concentration of total ammonia nitrogen shall not exceed those values shown as the chronic criterion in the following tables:

Temperature and pH-Dependent Values of the CCC (Chronic Criterion)

for Fish Early Life Stages Present – mg/L

	Temperature °C									
pH	***0***	***14***	***16***	***18***	***20***	***22***	***24***	***26***	***28***	***30***
6.5	*6.67*	*6.67*	*6.06*	*5.33*	*4.68*	*4.12*	*3.62*	*3.18*	*2.80*	*2.46*
6.6	*6.57*	*6.57*	*5.97*	*5.25*	*4.61*	*4.05*	*3.56*	*3.13*	*2.75*	*2.42*
6.7	*6.44*	*6.44*	*5.86*	*5.15*	*4.52*	*3.98*	*3.50*	*3.07*	*2.70*	*2.37*
6.8	*6.29*	*6.29*	*5.72*	*5.03*	*4.42*	*3.89*	*3.42*	*3.00*	*2.64*	*2.32*
6.9	*6.12*	*6.12*	*5.56*	*4.89*	*4.30*	*3.78*	*3.32*	*2.92*	*2.57*	*2.25*
7.0	*5.91*	*5.91*	*5.37*	*4.72*	*4.15*	*3.65*	*3.21*	*2.82*	*2.48*	*2.18*
7.1	*5.67*	*5.67*	*5.15*	*4.53*	*3.98*	*3.50*	*3.08*	*2.70*	*2.38*	*2.09*
7.2	*5.39*	*5.39*	*4.90*	*4.31*	*3.78*	*3.33*	*2.92*	*2.57*	*2.26*	*1.99*
7.3	*5.08*	*5.08*	*4.61*	*4.06*	*3.57*	*3.13*	*2.76*	*2.42*	*2.13*	*1.87*
7.4	*4.73*	*4.73*	*4.30*	*3.78*	*3.32*	*2.92*	*2.57*	*2.26*	*1.98*	*1.74*
7.5	*4.36*	*4.36*	*3.97*	*3.49*	*3.06*	*2.69*	*2.37*	*2.08*	*1.83*	*1.61*
7.6	*3.98*	*3.98*	*3.61*	*3.18*	*2.79*	*2.45*	*2.16*	*1.90*	*1.67*	*1.47*
7.7	*3.58*	*3.58*	*3.25*	*2.86*	*2.51*	*2.21*	*1.94*	*1.71*	*1.50*	*1.32*
7.8	*3.18*	*3.18*	*2.89*	*2.54*	*2.23*	*1.96*	*1.73*	*1.52*	*1.33*	*1.17*
7.9	*2.80*	*2.80*	*2.54*	*2.24*	*1.96*	*1.73*	*1.52*	*1.33*	*1.17*	*1.03*
8.0	*2.43*	*2.43*	*2.21*	*1.94*	*1.71*	*1.50*	*1.32*	*1.16*	*1.02*	*0.897*
8.1	*2.10*	*2.10*	*1.91*	*1.68*	*1.47*	*1.29*	*1.14*	*1.00*	*0.879*	*0.773*
8.2	*1.79*	*1.79*	*1.63*	*1.43*	*1.26*	*1.11*	*0.973*	*0.855*	*0.752*	*0.661*
8.3	*1.52*	*1.52*	*1.39*	*1.22*	*1.07*	*0.941*	*0.827*	*0.727*	*0.639*	*0.562*
8.4	*1.29*	*1.29*	*1.17*	*1.03*	*0.906*	*0.796*	*0.700*	*0.615*	*0.541*	*0.475*
8.5	*1.09*	*1.09*	*0.990*	*0.870*	*0.765*	*0.672*	*0.591*	*0.520*	*0.457*	*0.401*
8.6	*0.920*	*0.920*	*0.836*	*0.735*	*0.646*	*0.568*	*0.499*	*0.439*	*0.386*	*0.339*
8.7	*0.778*	*0.778*	*0.707*	*0.622*	*0.547*	*0.480*	*0.422*	*0.371*	*0.326*	*0.287*
8.8	*0.661*	*0.661*	*0.601*	*0.528*	*0.464*	*0.408*	*0.359*	*0.315*	*0.277*	*0.244*
8.9	*0.565*	*0.565*	*0.513*	*0.451*	*0.397*	*0.349*	*0.306*	*0.269*	*0.237*	*0.208*
9.0	*0.486*	*0.486*	*0.442*	*0.389*	*0.342*	*0.300*	*0.264*	*0.232*	*0.204*	*0.179*

Temperature and pH-Dependent Values of the CCC (Chronic Criterion)

for Fish Early Life Stages Absent – mg/L

Temperature °C

pH	***0-7***	***8***	***9***	***10***	***11***	***12***	***13***	***14***	***15****	***16****
6.5	*10.8*	*10.1*	*9.51*	*8.92*	*8.36*	*7.84*	*7.35*	*6.89*	*6.46*	*6.06*
6.6	*10.7*	*9.99*	*9.37*	*8.79*	*8.24*	*7.72*	*7.24*	*6.79*	*6.36*	*5.97*
6.7	*10.5*	*9.81*	*9.20*	*8.62*	*8.08*	*7.58*	*7.11*	*6.66*	*6.25*	*5.86*
6.8	*10.2*	*9.58*	*8.98*	*8.42*	*7.90*	*7.40*	*6.94*	*6.51*	*6.10*	*5.72*
6.9	*9.93*	*9.31*	*8.73*	*8.19*	*7.68*	*7.20*	*6.75*	*6.33*	*5.93*	*5.56*
7.0	*9.60*	*9.00*	*8.43*	*7.91*	*7.41*	*6.95*	*6.52*	*6.11*	*5.73*	*5.37*
7.1	*9.20*	*8.63*	*8.09*	*7.58*	*7.11*	*6.67*	*6.25*	*5.86*	*5.49*	*5.15*
7.2	*8.75*	*8.20*	*7.69*	*7.21*	*6.76*	*6.34*	*5.94*	*5.57*	*5.22*	*4.90*
7.3	*8.24*	*7.73*	*7.25*	*6.79*	*6.37*	*5.97*	*5.60*	*5.25*	*4.92*	*4.61*
7.4	*7.69*	*7.21*	*6.76*	*6.33*	*5.94*	*5.57*	*5.22*	*4.89*	*4.59*	*4.30*
7.5	*7.09*	*6.64*	*6.23*	*5.84*	*5.48*	*5.13*	*4.81*	*4.51*	*4.23*	*3.97*
7.6	*6.46*	*6.05*	*5.67*	*5.32*	*4.99*	*4.68*	*4.38*	*4.11*	*3.85*	*3.61*
7.7	*5.81*	*5.45*	*5.11*	*4.79*	*4.49*	*4.21*	*3.95*	*3.70*	*3.47*	*3.25*
7.8	*5.17*	*4.84*	*4.54*	*4.26*	*3.99*	*3.74*	*3.51*	*3.29*	*3.09*	*2.89*
7.9	*4.54*	*4.26*	*3.99*	*3.74*	*3.51*	*3.29*	*3.09*	*2.89*	*2.71*	*2.54*
8.0	*3.95*	*3.70*	*3.47*	*3.26*	*3.05*	*2.86*	*2.68*	*2.52*	*2.36*	*2.21*
8.1	*3.41*	*3.19*	*2.99*	*2.81*	*2.63*	*2.47*	*2.31*	*2.17*	*2.03*	*1.91*
8.2	*2.91*	*2.73*	*2.56*	*2.40*	*2.25*	*2.11*	*1.98*	*1.85*	*1.74*	*1.63*
8.3	*2.47*	*2.32*	*2.18*	*2.04*	*1.91*	*1.79*	*1.68*	*1.58*	*1.48*	*1.39*
8.4	*2.09*	*1.96*	*1.84*	*1.73*	*1.62*	*1.52*	*1.42*	*1.33*	*1.25*	*1.17*
8.5	*1.77*	*1.66*	*1.55*	*1.46*	*1.37*	*1.28*	*1.20*	*1.13*	*1.06*	*0.990*
8.6	*1.49*	*1.40*	*1.31*	*1.23*	*1.15*	*1.08*	*1.01*	*0.951*	*0.892*	*0.836*
8.7	*1.26*	*1.18*	*1.11*	*1.04*	*0.976*	*0.915*	*0.858*	*0.805*	*0.754*	*0.707*
8.8	*1.07*	*1.01*	*0.944*	*0.885*	*0.829*	*0.778*	*0.729*	*0.684*	*0.641*	*0.601*
8.9	*0.917*	*0.860*	*0.806*	*0.756*	*0.709*	*0.664*	*0.623*	*0.584*	*0.548*	*0.513*
9.0	*0.790*	*0.740*	*0.694*	*0.651*	*0.610*	*0.572*	*0.536*	*0.503*	*0.471*	*0.442*

**At 15^{o} C and above, the criterion for fish Early Life Stage absent is the same as the criterion for fish Early Life Stage present.*

(C) The highest four-day average within a 30-day period should not exceed 2.5 times the chronic values shown above.

(D) Temperature values used will be 14^{o} C when fish early life stages are absent and the ecoregion temperature standard for the season when fish early life stages are present. The pH values will be the ecoregion mean value from least-disturbed stream data.

PHASE II DATA QUALITY REQUIREMENTS FOR AMMONIA:

Only discrete data will be used for ammonia assessments. Total ammonia – nitrogen samples must be paired with concurrently measured *in situ* pH and temperature data, as applicable.

Ammonia - Acute Exposure

1.Temporal requirements

- Collected year round.

2. Minimum distribution and quantity requirements

- A minimum of 10 samples; unless an assessment of non-attainment can be reached in fewer than 10 samples.
- For streams and rivers:
  - Evenly distributed over at least 2 years and 3 quarters; unless an assessment of non-attainment can be reached in fewer than 10 samples.
- For lakes and reservoirs:
  - A minimum of 10 quarterly samples; unless an assessment of non-attainment can be reached in fewer than 10 samples.

3. Spatial requirements

- For streams rivers, lakes, and reservoirs - none that are not already covered in Phase I requirements.

Ammonia - Chronic Exposure
Fish Early Life Stages Present

1. Temporal requirements

- Collected when early life stage fishes are present.
  - The months used in assessment are April through October, except on the trout water segment of the Little Red River, which is year-round.

2. Minimum distribution and quantity requirements

- A minimum of 10 samples unless an assessment of non-attainment can be reached in fewer than 10 samples.
- For streams and rivers – evenly distributed over at least 2 years and 3 seasons; unless non – attainment can be reached in fewer than 10 samples.
- For lakes and reservoirs – a minimum of 10 quarterly samples unless non-attainment can be reached in fewer than 10 samples

3. Spatial requirements

- For streams and rivers – none that are not already covered in Phase I requirements.
- For lakes and reservoirs – take samples within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

Ammonia - Chronic Exposure
Fish Early Life Stages Absent

1. Temporal requirements

- Collected when early life stage fishes are present.
  - The months used in assessment are November through March, except on the trout water segment of the Little Red River, which is year-round.

2. Minimum distribution and quantity requirements

- A minimum of 10 samples unless an assessment of non-attainment can be reached in fewer than 10 samples.
- For streams and rivers – evenly distributed over at least 2 years and 3 seasons; unless non – attainment can be reached in fewer than 10 samples.
- For lakes and reservoirs – a minimum of 10 quarterly samples unless non-attainment can be reached in fewer than 10 samples

3. Spatial requirements

- For streams and rivers, none that are not already covered in Phase I requirements.
- For lakes and reservoirs, take samples within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

ASSESSMENT METHODOLOGY FOR AMMONIA:

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2. Total ammonia nitrogen will be evaluated based on concurrently measured instream pH and temperature, as applicable, at the time of sample collection using APC&EC Rule 2.512(A)–(C) criteria. The Chronic Criterion for fish early life stages present (Rule 2.512(B)) apply when early life stage fishes are present in rivers and streams, or within the epilimnion of lakes and reservoirs

LISTING METHODOLOGY:

Stream, river, lake and reservoir AUs may be listed as non-support for ammonia toxicity if any one of the following criteria are violated:

For Rule 2.512(A) Acute Criterion - If **more than one (>1) violation** of the 1-hour average concentration of total ammonia nitrogen exceeds the calculated acute criterion within the 3-year period of record, even if the minimum of 10 samples has not been reached.

For Rule 2.512(B) Chronic Criterion – If the **monthly average concentration of total ammonia nitrogen exceeds** the chronic criterion, even if the minimum of 10 samples has not been reached. This method can only be applied if there are **at least 4 samples** per month.

OR

– If the **highest 4-day average within a 30-day period exceeds 2.5 times** the chronic criterion, even if the minimum of 10 samples has not been reached. This method can also apply to individual samples if there are **less than 4 samples** per month.

DELISTING METHODOLOGY:

An AU can only be delisted by the same criterion that was used to list it. For example, if an AU was listed using the Rule 2.512(A) acute criterion, it can only be delisted using the Rule 2.512(A) acute criterion delisting methodology. Stream and river AUs, as well as lakes and reservoirs, may be listed as support for ammonia toxicity criteria:

For Rule 2.512(A) Acute Criterion - If **no more than one violation (<1)** of the 1-hour average concentration of total ammonia nitrogen exceeds the calculated acute criterion within the 3-year period of record. A minimum of 10 samples must be reached to make an assessment of attainment.

For Rule 2.512(B) Chronic Criterion – If the **monthly average concentration of total ammonia nitrogen does not exceed** the chronic criterion. A minimum of 10 evenly distributed samples must be reached to make an assessment of attainment. This method can only be applied if there are **at least 4 samples** per month.

Chronic Criterion - If the **highest 4-day average within a 30-day period does not exceed 2.5 times** the chronic criterion. A minimum of 10 evenly distributed samples must be reached to make an assessment of attainment. This method can also apply to individual samples if there are **less than 4 samples** per month.

Arkansas River Valley Streams (>10 mi^2 watershed)

METRIC	4	2	0
% Sensitive Individuals Avg. = 12.8 Std. = 11.8	>3	1 – 3	<1
% Cyprinidae (Minnows) Avg. = 35.3 Std. = 8.3	>27 – 43	20 – 27 **or** >43 – 51	<20 **or** >51
% Ictaluridae (Catfishes) Avg. = 15.7 Std. = 10.4	>5 total ictalurids **and** ≤7% bullheads from total catch	3 – 5 **and** ≤7% bullheads from total catch	<3 total ictalurids **or** >7% bullheads from total catch
% Centrarchidae (Sunfishes) Avg. = 21.0 Std. = 4.6	>16 – 26 **and** ≤12% Green sunfish from total catch	11 – 16 **or** >26 – 31 **and** ≤12% Green sunfish from total catch	<11 **or** >31 **or** >12% Green sunfish from total catch
% Percidae (Darters) Avg. = 11.9 Std. = 7.6	>4	1 – 4	<1
% Primary Feeders Avg. = 25.8 Std. = 5.9	<30	30 – 35	>35
% "Key" Individuals Avg. = 40.0 Std. = 19.0	>20	10 – 20	<10
Diversity Avg. = 3.74 Std. = 0.23	>3.51	3.51 – 3.28	<3.28

Total Score

25-32 Mostly Similar
24-17 Generally Similar
16-9 Somewhat Similar
8-0 Not Similar

Boston Mountains Streams (>10 mi^2 watershed)

METRIC	4	2	0
% Sensitive Individuals Avg. = 43.0 Std. = 13.0	>30	30 – 16	<16
% Cyprinidae (Minnows) Avg. = 43.0 Std. = 17.0	>25 – 60	15 – 25 **or** > 60 - 75	<15 **or** >75
% Ictaluridae (Catfishes) Avg. = 8.8 Std. = 7.3	>4 **and** ≤1% bullheads from total catch	2 – 4 **and** ≤1% bullheads from total catch	<2 **or** >1% bullheads from total catch
% Centrarchidae (Sunfishes) Avg. = 23.4 Std. = 14.8	>10 – 40 **and** ≤18% Green sunfish from total catch	6 – 10 **or** >40 – 55 **and** ≤18% Green sunfish from total catch	<6 **or** >55 **or** >18% Green sunfish from total catch
% Percidae (Darters) Avg. = 16.6 Std. = 4.8	>10	6 – 10	<6
% Primary Feeders Avg. = 24.3 Std. = 11.1	<35	35 – 45	>45
% "Key" Individuals Avg. = 42.7 Std. = 6.7	>35	25 – 35	<25
Diversity Avg. = 3.45 Std. = 0.3	>3.15	3.15 – 2.85	<2.85

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Total Score

25-32 Mostly Similar
24-17 Generally Similar
16-9 Somewhat Similar
8-0 Not Similar

Delta –Channel Altered Streams (>10 mi^2 watershed)

METRIC	4	2	0
% Sensitive Individuals	N/A	N/A	N/A
% Cyprinidae (Minnows) Avg. = 18.8 Std. = 6.9	<10 – 26	2 – 10 **or** >26 – 34	<2 **or** >34
% Ictaluridae (Catfishes) Avg. = 24.7 Std. = 15.2	<6 – 40 **and** ≤3% bullheads from total catch	3 – 6 **or** > 40 – 50 **and** ≤3% bullheads from total catch	<3 **or** >50 **or** >3% bullheads from total catch
% Centrarchidae (Sunfishes) Avg. = 23.6 Std. = 14.5	>6 – 40 **and** ≤30% Green sunfish from total catch	3 – 6 **or** >40 - 55 **and** ≤30% Green sunfish from total catch	<3 **or** >55 **or** >30% Green sunfish from total catch
% Percidae (Darters) Avg. = 0.1 Std. = 0.9	>0.1	0.1 – 0.05	<0.05
% Primary Feeders Avg. = 12.5 Std. = 8.1	<20	20 – 30	>30
% "Key" Individuals Avg. = 47.5 Std. = 18.8	>25	10 – 25	<10
Diversity Avg. = 2.72 Std. = 0.21	>2.51	2.51 – 2.30	<2.30

Total Score
22-28 Mostly Similar
21-15 Generally Similar
14-8 Somewhat Similar
7-0 Not Similar

Delta –Least Disturbed Streams (>10 mi^2 watershed)

METRIC	4	2	0
% Sensitive Individuals	N/A	N/A	N/A
% Cyprinidae (Minnows) Avg. = 22.8 Std. = 19.9	<10 – 40	5 – 10 **or** >40 – 55	<5 **or** >55
% Ictaluridae (Catfishes) Avg. = 9.2 Std. = 7.5	>3 **and** ≤13% bullheads from total catch	1 – 3 **and** ≤13% bullheads from total catch	<1 **or** >13% bullheads from total catch
% Centrarchidae (Sunfishes) Avg. = 31.4 Std. = 16.5	>20 – 45 **and** ≤8% Green sunfish from total catch	15 – 20 **or** >45 – 60 **and** ≤8% Green sunfish from total catch	<15 **or** >60 **or** >8% Green sunfish from total catch
% Percidae (Darters) Avg. = 9.8 Std. = 6.3	>3	1 – 3	<1
% Primary Feeders Avg. = 6.5 Std. = 6.7	<15	15 – 25	>25
% "Key" Individuals Avg. = 16.9 Std. = 14.9	>10	5 – 10	<5
Diversity Avg. = 3.73 Std. = 0.36	>3.37	3.37 – 3.01	<3.01

Total Score
22-28 Mostly Similar
21-15 Generally Similar
14-8 Somewhat Similar
7-0 Not Similar

Gulf Coastal – Spring Influenced Streams (>10 mi^2 watershed)

METRIC	4	2	0
% Sensitive Individuals Avg. = 18.4 Std. = 5.2	>3	2 – 3	<2
% Cyprinidae (Minnows) Avg. = 31.5 Std. = 10.9	>15 – 45	5 – 15 **or** >45 – 60	<5 **or** >60
% Ictaluridae (Catfishes) Avg. = 16.3 Std. = 8.3	>5 **and** ≤8% bullheads from total catch	<2 – 5 **and** ≤8% bullheads from total catch	<2 **or** >8% bullheads from total catch
% Centrarchidae (Sunfishes) Avg. = 19.0 Std. = 7.0	>9 – 28 **and** ≤8% Green sunfish from total catch	4 – 9 **or** >28 – 38 **and** ≤8% Green sunfish from total catch	<4 **or** >38 **or** >8% Green sunfish from total catch
% Percidae (Darters) Avg. = 8.0 Std. = 0.8	>6	3 – 6	<3
% Primary Feeders Avg. = 9.5 Std. = 9.0	<20	20 – 30	>30
% "Key" Individuals Avg. = 43.4 Std. = 12.2	>26	12 – 26	<12
Diversity Avg. = 3.89 Std. = 0.03	>3.79	3.79 – 3.69	<3.69

Total Score
25-32 Mostly Similar
24-17 Generally Similar
16-9 Somewhat Similar
8-0 Not Similar

Gulf Coastal – Typical Streams (>10 mi^2 watershed)

METRIC	4	2	0
% Sensitive Individuals Avg. = 1.8 Std. = 1.4	>1	1 – 0.5	<0.5
% Cyprinidae (Minnows) Avg. = 19.5 Std. = 13.0	>5 – 35	<5 **or** >35 – 45	>45
% Ictaluridae (Catfishes) Avg. = 3.1 Std. = 2.9	>1 **and** ≤8% bullheads from total catch	0.5 – 1 **and** ≤8% bullheads from total catch	<0.5 **or** >8% bullheads from total catch
% Centrarchidae (Sunfishes) Avg. = 32.3 Std. = 10.9	>28 – 47 **and** ≤8% Green sunfish from total catch	18 – 28 **or** >47 – 57 **and** ≤8% Green sunfish from total catch	<18 **or** >57 **or** >8% Green sunfish from total catch
% Percidae (Darters) Avg. = 14.5 Std. = 3.4	>10	6 – 10	<6
% Primary Feeders Avg. = 8.0 Std. = 6.5	<15	15 – 22	>22
% "Key" Individuals Avg. = 22.4 Std. = 8.4	>19	13 – 19	<13
Diversity Avg. = 4.13 Std. = 0.24	>3.89	3.89 – 3.65	<3.65

Total Score

25-32 Mostly Similar
24-17 Generally Similar
16-9 Somewhat Similar
8-0 Not Similar

Ouachita Mountains Streams (>10 mi^2 watershed)

METRIC	4	2	0
% Sensitive Individuals Avg. = 33.8 Std. = 7.3	>24	16 – 24	<16
% Cyprinidae (Minnows) Avg. = 51.7 Std. = 7.0	>45 – 60	36 – 45 **or** >60 – 67	<36 **or** >67
% Ictaluridae (Catfishes) Avg. = 3.0 Std. = 1.7	>1 **and** ≤2% bullheads from total catch	0.5- 1 **and** ≤2% bullheads from total catch	<0.5 **or** >2% bullheads from total catch
% Centrarchidae (Sunfishes) Avg. = 18.9 Std. = 7.1	>8 – 26 **and** ≤7% Green sunfish from total catch	3 – 8 **or** >26 – 33 **and** ≤7% Green sunfish from total catch	<3 **or** >33 **or** >7% Green sunfish from total catch
% Percidae (Darters) Avg. = 20.0 Std. = 5.4	>14	8 – 14	<8
% Primary Feeders Avg. = 37.3 Std. = 9.6	<48	48 – 58	>58
% "Key" Individuals Avg. = 36.0 Std. = 11.8	>23	10 – 23	<10
Diversity Avg. = 3.15 Std. = 0.52	>2.63	2.63 – 2.11	<2.11

Total Score
25-32 Mostly Similar
24-17 Generally Similar
16-9 Somewhat Similar
8-0 Not Similar

Ozark Highlands Streams (All Watersheds)

METRIC	5	3	1†
% Sensitive Individuals	>31	31 – 20	<20
% Cyprinidae (Minnows)	>48 – 64	39 – 48 **or** >64 – 73	<39 **or** >73
% Ictaluridae (Catfishes)	>2 **and** ≤3% bullheads from total catch	1 – 2 **and** ≤3% bullheads from total catch	<1 **or** >3% bullheads from total catch
% Centrarchidae (Sunfishes)	4 – 15 **and** ≤2% Green sunfish from total catch	<4 **or** > 15 – 20 **and** ≤ 2% Green sunfish from total catch	>20 **or** >2% Green sunfish from total catch
% Percidae (Darters)	>11	5 – 11	<5
% Primary Feeders	<42	42 – 49	>49
% "Key" Individuals	>23	23 – 16	<16
Diversity	>2.77	2.77 – 2.37	<2.37
# Species	>(wtrshd*0.034)+16.45	(wtrshd*0.034)+16.45 – (wtrshd*0.034)+12.26	<(wtrshd*0.034)+12.26

†if a raw metric score is zero, score as zero, except for Primary Feeders

Total Score
37-45 Mostly Similar
25-36 Generally Similar
13-24 Somewhat Similar
12-0 Not Similar

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